THE ENGINEER

A Seven-Day Journal

Pig Iron Production and Coke Quality

IN the course of a paper before the Coke Oven Managers' Association in Sheffield on Wednesday last, Jan 9th, Dr. H. L. Riley said that a substantial increase in the annual production of pig iron could be made by the improvement of the quality of the coke used. This step would, it was contended, increase pig iron production by some hundreds of thousands of tons, but with the present shortage of coke pig iron producers had little or no choice in their coke purchases. Dr. Riley said that detailed examination of the cokes produced in South Yorkshire and elsewhere had shown that two factors were largely responsible for the production of inferior blast-furnace coke. One of these factors was inadequate preparation of the slack charged to the coke ovens, and the other was incomplete combustion. As there was at present an urgent need for the most stringent economy in the use of fuel of any kind it was considered imperative that immediate action should be taken to improve the quality of the cokes used by pig iron producers. These cokes should be at least equal to those produced at the works of iron and steel firms, which were far superior to those from other sources. At present, said Dr. Riley, hundreds of thousands of tons of coke were being wasted every year, and by a stricter technical control of carbonisation considerable improvements and economies could be brought about.

Productivity Team on Fuel Conservation

AT the end of this month a specialist team will leave this country for the United States to study the conservation of fuel for the preparation of a report to the Anglo-American Council on Productivity. The leader of this team will be Mr. W. L. Boon, of Powell Duffryn Technical Services, Ltd., and its secretary, Mr. W. J. Dickie, of the Federation of British Industries. Other members of the team have been nominated by bodies representing the engineering, heating and ventilating, cotton, woollen, brewing, chemical and paper industries, the T.U.C., and the Institute of Cost and Works Accountants. Furnace industries and those depending largely upon coal as a raw material—such as iron and steelmaking, gas, electrical power generation, pottery manufacture, &c.—are expressly excluded from the inquiry, and domestic heating will only be studied as far as its demands affect the peak load of electricity supply undertakings. During its tour in the United States the team will consider power installations of diverse kinds in many industries and the products of firms manufacturing ancillary equipment, such as automatic control gear and that for the utilisation of exhaust steam through back-pressure generation, &c. It is also planned to hold conferences with American associations concerned with coal, gas and petroleum. It is expected that the report to be prepared by the team will present recommendations on the immediately pressing problems of economising existing resources, and also on a comprehensive long-term policy of fuel utilisation in this country.

Steel Allocations to Industry

A GOVERNMENT statement in connection with the steel situation, which was made on Friday, January 4th, reiterates that the steel shortage and the mounting claims of the defence programme and the export drive have made it imperative to introduce a system of allocation of supplies based on the national needs. Steel supplies are no less than 1½ million tons short of the national requirements. The home market will of necessity suffer as a result of restriction of steel supplies, but the statement points out that the minimum needs of basic industries, such as coal, transport and power production, must be protected. For this reason the sacrifice will have to be borne by other steel-using industries in proportions that vary with their importance to the national economy. Individual firms are expected to co-operate in carrying out the principles behind the scheme, and those which have their allocation reduced are expected to let any cuts fall upon home rather than export production if both markets are being supplied. Comprehensive allocation is being carried out with great care, it is stated. After close examination a central committee allots quantities of steel amongst the main broad classes of national need, then individual departments subdivide the allotment amongst the concerns within their administration. The Government is making strenuous efforts to find means of raising the amount of supplies by increasing imports of ores and semi and finished steel from wherever they are available. The announcement concludes with a statement to the effect that allocations will be increased, with regard to national priorities, as soon as more steel is available.

European Transport Statistics

THE second annual bulletin of transport statistics, published recently by the Inland Transport Division of the United Nations Economic Commission for Europe, reviews the transport situation in Europe in 1950. This bulletin shows that there was a general increase in traffic by all forms of transport in most European countries in 1950, as compared with 1949. An account is given of the trends of passenger and freight traffic in inland transport, and a comparison is made between the volume of traffic by railway and inland waterway in the two years and of the volume of production and imports during 1949 and 1950. Statistical tables and charts provide data on the networks of railways, roads and inland waterways, and on mobile equipment and the utilisation of equipment. In addition to the fourteen countries covered in the 1949 bulletin, statistics are also given for Greece, Poland and Yugoslavia. It is of interest to note that Switzerland had the greatest volume of passenger traffic by rail per head of the population and the number of passenger trains per day per kilometre of line. The second place for volume of traffic per head of population was taken by Poland. Freight traffic density in railways, measured in ton-kilometres, was greatest in the Western zones of Germany. If this density is measured by the number of trains it was greatest in the United Kingdom. On inland waterways the density of traffic was greatest in the Western zones of Germany. It is shown in the road transport statistics that the number of vehicles in 1950 had appreciably increased over that in 1938 in most countries. In 1950 the number of inhabitants per motor vehicle ranged from fifteen in the United Kingdom and twenty in France to 819 in Turkey.

Coal Shortage and Efficient Use

AT a luncheon of the Coal Industry Society in London on Monday last, Sir Claud Gibb, F.R.S., said that he considered that in the foreseeable future this country would suffer coal shortages and cease to be a coal exporting nation. This view, he emphasised, was his own and he was not speaking as a member of the National Fuel Policy Committee. He did not agree with the optimism expressed by the National Coal Board and thought that it would not be able to meet demands for coal in the foreseeable future unless there was a world-wide depression, with consequent widespread unemployment in this country, or unless we changed our ideas on fuel utilisation. With the labour shortage generally so acute the mines were not likely to experience any appreciable increase in manpower. The efficiency of coal utilisation to-day was probably little more than 15 per cent, but, said Sir Claud, this efficiency could be 30 per cent if we used only the most modern domestic grates, gas furnaces and gas producing plant, and had sufficient new high-pressure, high temperature electrical generating plant. While ignorance might be an excuse for wastage of domestic coal he considered that there was no excuse for waste in industry and he would inflict heavy penalties on industrial concerns which were wasteful. Another speaker at the luncheon, Sir Hubert Houldsworth, chairman of the National Coal Board, spoke of the great waste of fuel in households and called for a combined effort on the part of producers and consumers to halt this wastage. Only 25 per cent of the useful heat of solid fuel was obtained in the average household appliance. Following successful experiments in its own houses, the Board was surveying all of its house property and hoped to engage in a vigorous campaign for the use of new improved appliances.

An Inland Waterway Survey by Asian Experts

A THREE months' tour to study the organisation and equipment of inland waterways in all parts of the world has just been completed by a group of experts from Burma, India, Pakistan, Thailand and Viet-Nam. This tour was organised by the United Nations Technical Assistance Administration to give the experts an opportunity to learn from experience in overseas countries means of improving transport methods on rivers and canals in Asia. An interim report states that three things which impressed the visitors during the tour were the economies made possible by welded ship construction, the Kort nozzle for propulsion of vessels and the use of light alloys for vessels. Investigations were particularly directed towards the methods of operation, loading and unloading of vessels, maintenance and repair, water conservancy measures, marking of channels, &c. The report prepared by the experts recommends that diesel engines should be used to replace steam engines on craft, that the Kort nozzle should be introduced, trials should be made with push and pull towing, an increased use should be made of light alloys for shallow draft dumb craft, a modest start should be made with mechanisation of cargo handling, and that water conservancy should be the responsibility of governments rather than of private companies. Consideration was also given to means of applying the findings of the group in their various countries. It is expected that the trip will have one important outcome in that it has produced a nucleus of qualified staff that will be able to guide inland water transport developments in Asian countries on modern principles adapted to suit local conditions. In the report the experts from each country have outlined the particular points of interest in the tour and those which might provide means of improvement on the inland waterways of their own countries.

Civil Engineering in 1951

No. II—(*Continued from page 12, January 4th*)

DURING 1951 some interesting works for the construction or rebuilding of docks and harbours were in progress under the direction of British consulting engineers or harbour authorities. A considerable amount of new construction was being carried out abroad, mainly in the British Empire, for which British consulting engineers were responsible, and several examples of such work are given in this article. First of all, however, we have included some instances of progress in this country.

The largest scheme which is at present being undertaken in England is the construction of a new river entrance lock at Liverpool, by the Mersey Docks and Harbour Board. The cost of the entire scheme, which will take nine years to complete, is estimated at over £10,000,000.

The North Docks form the largest and most important deep-water system in the Port of Liverpool and, though for the most part now well over seventy years old, the lay-out is still adequate to meet present-day requirements, except in the vicinity of Canada Basin, where several quays were narrow and certain water spaces restricted; it is here that the new entrance has been sited, as may be seen from the accompanying plan. When completed the new lock will supplement the deep-water Gladstone River entrance lock, opened twenty-five years ago, at the extreme north end of the system, and will replace the obsolete Canada and Langton locks, which are being demolished as part of the scheme.

The new lock will have a clear working length of 825ft between inner and outer sliding caissons, a width of 130ft and will provide a lift of approximately 30ft at low water in the river, when there will be 19ft of water on the sills, while at half tide the corresponding depth will be 34ft, and at high water of spring tides 49ft. A third sliding caisson divides the lock into subsidiary compartments of 518ft and 275ft clear working length.

The lock walls are to be mass concrete gravity structures located for the most part on the site of the tidal Canada Basin, where they will be constructed under cover of a series of individual cofferdams. The new quays inside the dock system will also have mass concrete gravity walls constructed in deep trenches, where the alignment falls inside the present quay areas, but some form of openwork construction may be adopted where the alignment crosses present water space. The guide wall at the river approach to the lock will have to be built in the river outside the existing wall, which has shallow foundations, so as to enable the fairway to be dredged to below sill level. Monoliths are being considered for part of this wall.

Complementary to the new river entrance is the deepening by 5ft 9in and widening by 50ft 3in, to a width of 130ft, of the existing passage between Canada and Brocklebank docks to afford commensurate access from the lock to the exceptionally deep berths in Canada and Huskisson docks. This passage will be provided with a single sliding caisson carrying a roadway on a falling deck.

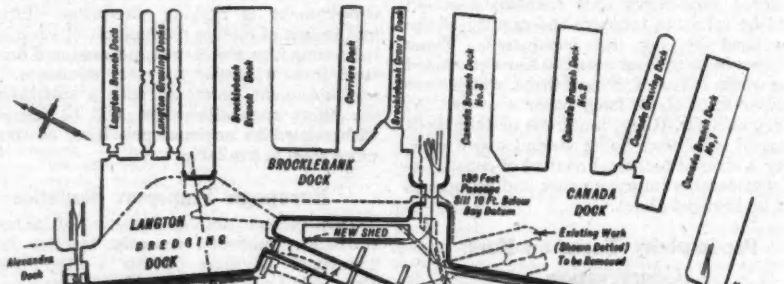
The scheme involves the construction of about 5600 linear feet of new quays and walls inside the docks and 5300ft of wall in the lock and river. Dredging in the river and docks is expected to amount to about 1,900,000 cubic yards net and the filling of Canada Basin to about 375,000 cubic yards. The diversion and extension of three large town outfall sewers is also involved and various other subsidiary works. The bulk of the work is being designed and carried out by direct labour. However, as exceptions, the diversion of the Miller's Bridge outfall sewer in heading under Langton Dock is being carried out by the Norwest Construction Company, Ltd., with Messrs. Ward, Ashcroft and Parkman acting as consulting engineers, and the four sliding caissons are being designed and built by Sir William Arrol and Co., Ltd.

The first phase of the scheme involves the reconstruction of the Canada-Brocklebank Passage, together with the adjacent quay walls and the diversion of the town sewers, while a start has been made with the cofferdams for the east wall of the entrance lock. During the year under review two single-skin cofferdams, internally braced by timber walings and steel struts on more or less conventional lines, were constructed on the east side of Canada-Brocklebank Passage and finally withdrawn; one of the cofferdams is illustrated opposite. Under cover of the dams the east end abutments were built for the closing dams, which will eventually seal off the passage at its north and south ends. These closing dams will also be constructed on conventional lines, and will enable the passage to be pumped out for the completion of the new east side, including part of the new invert. On the west side of the passage part of the new wall was concreted in a deep trench sheeted by steel piling and braced with timber walings and steel struts. The presence of old sewers and culverts and masonry quay walls in poor condition were among the hazards encountered. The concreting stage was also reached on the first length of new wall on the west side of Brocklebank Dock. Here, again, the bulk of the work will be in deep trenches.

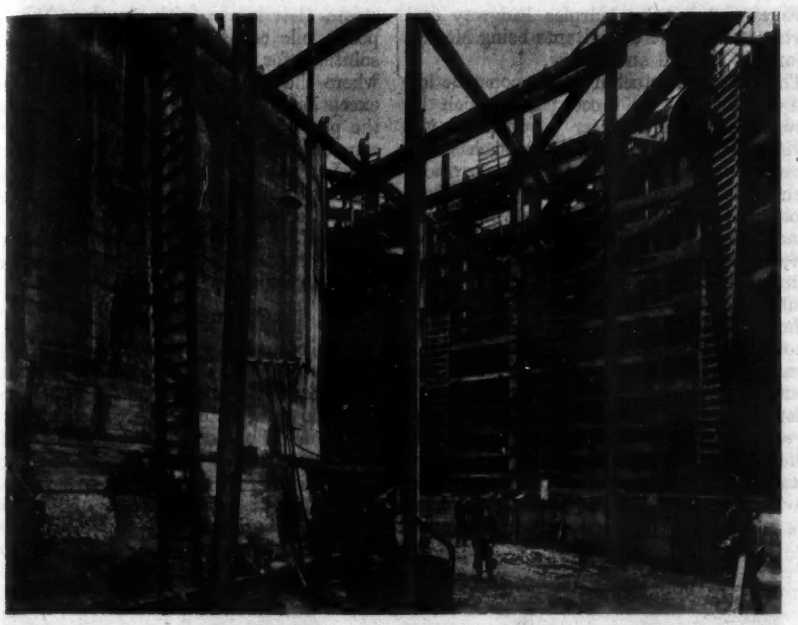
The old Canada Lock was sealed off at the outer end by a ship caisson and a 200ft length of wall constructed, forming part of the new quays. This wall now serves to seal off the outer end of the lock and the ship caisson has been transferred to the inner end to form a dry dock for the erection of the first sliding caisson. The Northern and Bankhall relief sewer outfalls are being combined and extended in a brick-lined reinforced concrete box culvert 11ft wide by 13ft deep in section: 236ft of sewer has already been constructed in trench and cofferdams are being built for those lengths which cross the south-east corner of Canada Basin.

The diversion of Miller's Bridge sewer is now nearly completed. This sewer was carried under Langton Dock in a 6ft diameter brick-lined tunnel 800ft long, driven through rock. The invert of the sewer at the deeper end is 106ft below quay level, giving a minimum cover of about 20ft of undisturbed rock above the crown, with a further cover of about 35ft of soft ground to dock bottom. Though the rock, which is a sandstone of one of the Bunter formations, was water-bearing, the work was carried out in free air. The shafts are lined with bolted reinforced concrete segments placed by underpinning, except in one instance, where one of the shafts passed through a bed of silt, which necessitated a sectional steel cylinder being driven ahead inside the segments to an ultimate length of 24ft. The heading was lined with similar segments as the work proceeded as a precaution against excessive seepage of water and trouble due to softening of the rock.

Other work in progress for the Mersey Docks and Harbour Board in 1951 included a continuation of the very extensive restoration of war damage to dockside sheds and of the large reinforced concrete shed damaged by fire in 1949. Another repair job in progress during the year involved an existing sandstone masonry dock wall on the west side of Harrington Dock. The wall was built in about 1880 and recently moved slightly by tilting and sliding. It has now been strengthened by the addition of a mass concrete facing wall keyed into the old masonry. To give added resistance to sliding the new construction is keyed into the sandstone rock forming the dock bottom by broad flange beams acting as dowels. The addition of the new wall serves the further purpose of widening the quay from 5ft 6in to 13ft 3in, the original width being inadequate by modern standards. As an innovation, steel frames are being erected at a number of the shed doorways, carrying a beam to which house falls may be attached and operated with ship's gear to form a union purchase. The facing wall was constructed under cover of specially designed cofferdam units on the following lines. A skeleton framework of box piles and walings of 70ft length and weighing 50 tons was prefabricated on the quay and lowered into holes previously "jumped" into the rock



LAYOUT OF LANGTON-BROCKLEBANK AND CANADA DOCKS IMPROVEMENT AT MERSEY DOCKS



COFFERDAM IN CANADA-DOCK AT BROCKLESBANK PASSAGE AT MERSEY DOCKS

bottom of the dock. The remaining sheet piles were then driven and the walings shored off from the wall by struts placed by divers. Three such units were employed, continuous construction being achieved by "leap-frogging" the dams along the length of the quay. The work, which is now nearing completion, is expected to cost over £220,000.

DRY DOCK RECONSTRUCTION

Dry dock facilities are expensive to build and several of the works in progress during the year were in the repair of old installations, rather than in new construction. Such reconstruction work is often of considerable technical interest, for many reasons; for example, foundation conditions are likely to be poor, or the site restricted, and delays to shipping using the installations concerned may be very costly, compared with the value of the civil engineering works.

One example of such work was the reconstruction of Barry Commercial Dry Dock, which was recently carried out on behalf of the lessees, C. H. Bailey, Ltd., the ship repairers of Cardiff, Newport and Barry. Hitherto it has been usual for specialist firms to design and build the caisson gates for large docks, but in this case the difficulty in obtaining shipyard labour and material and also the high cost of carrying out work of the ordinary kind made it imperative to improvise. Gates were accordingly designed by the consulting engineers, Messrs. Maunsell, Posford and Pavry, making use of simple and readily obtainable material and the gates were afterwards constructed by John Howard and Co., Ltd., the general contractor, in the course of the other dock reconstruction work, using ordinary civil engineering labour. The gates shown in the accompanying illustration are now in use and appear to be entirely satisfactory.

This is also apparently the only dock in the world where mock altars are in use. Part of the reconstruction work consisted in narrowing the dock so as to make it suitable for berthing modern ships instead of berthing two ships abreast, as was intended when the dock was originally designed and built. To have narrowed the dock by building new solid walls would, of course, have been perfectly feasible, but it was thought that a neater and cheaper solution would be to construct, in reinforced concrete, a skeleton wall comprising the usual shoring altars and carrying a reinforced concrete deck slab over the top of the framework—the latter designed to carry two heavy cranes on two tracks, the larger of which straddles the smaller. The sections of dock where mock altars were in the course of construction in 1951 can be seen in the illustration below.

The reconstruction of the No. 1 drydock of T. W. Greenwell and Co., Ltd. at South Dock, Sunderland, which was commenced in 1950, is expected to be completed during 1952. The new dock, a photograph of which is reproduced overleaf, will be 675ft long by 98ft between copes, and will have a clear entrance width of 87ft 2in with 27ft 4in of water over the sill at M.H.W.S.T.

Excavation for the new dock involved the complete demolition of the old dock, soft excavation to a depth of approximately 16ft below the original ground level, followed by rock excavation in magnesian limestone. The walls of the dock are of mass concrete, founded on the rock, with a 4ft thick mass concrete facing wall below rock level. The dock floor is also of mass concrete varying in thickness from 4ft 6in at the sides to 5ft at the centre. A system of rubble drains behind the walls and under the floor is provided and water will discharge through a series of ball valves along each side of the dock. This seepage water will drain to sumps, for removal by the dock pumps. The new entrance will be closed by a steel "box" gate.

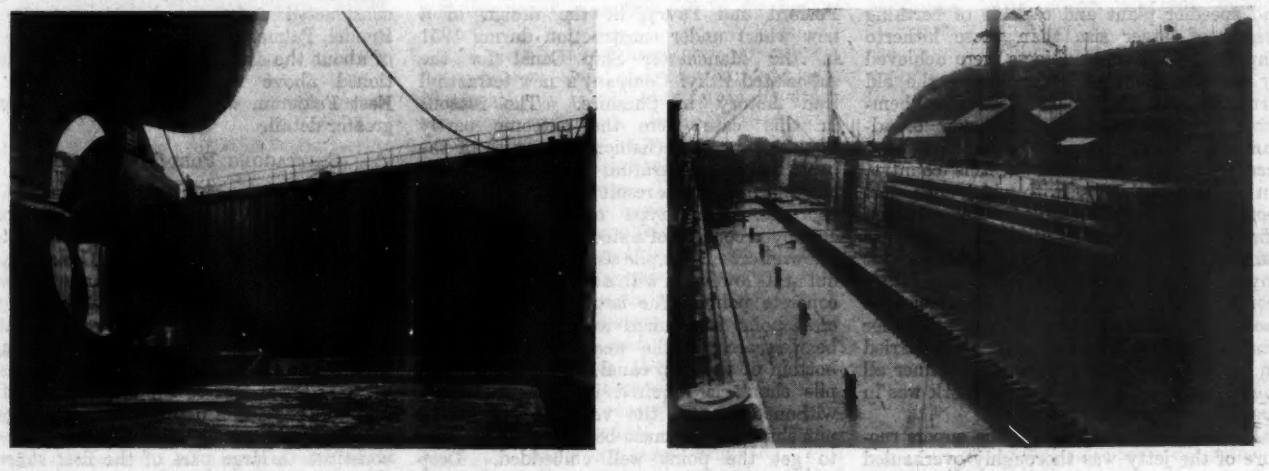
By the addition of two concrete buttresses it has been found possible to keep the old dock gates sufficiently watertight to permit the construction of most of the new dock without the need for a cofferdam. A cofferdam was, however, necessary for the construction of the entrance and a large double-walled, full-tide structure was nearing completion at the end of the year.

Further work in hand for T. W. Greenwell and Co., Ltd., at Sunderland included the extension by 50ft of the No. 2 dry dock and the extension of the fitting-out quay by 210ft, the latter work being carried out in reinforced concrete. The consulting engineers are Sir William Halcrow and Partners, the civil engineering contractors being the Demolition and Construction Company, Ltd., whilst the gate contract was awarded to Vickers-Armstrongs, Ltd.

JETTIES

An interesting work under construction in the Thames Estuary in 1951 was the new Thames Haven jetty, near the Shell Haven refinery in Essex. The jetty is L-shaped, the approach being 414ft long and 23ft wide, and the head 240ft long and 40ft wide; it will accommodate tankers of up to 38,000 deadweight tons, and ½ will be completed this year.

Both the approach and the head of the jetty are being supported on 8ft diameter concrete cylinders, consisting of precast



CAISSON GATE, SKELETON WALL AND MOCK ALTARS AT BARRY COMMERCIAL DOCK

reinforced hollow cylindrical sections, each 8ft long. The sections are spigot jointed together and the lower edge of the bottom section is fitted with a steel cutting edge for penetrating the river bed. The cylinders are sunk into the river bed to a depth of about 34ft by heavy weights (about 120 tons on each cylinder), and then filled with concrete suitably reinforced. The shore end of the approach, where it rests on the sea wall, is being carried on two bored piles. There are five 77ft clear spans on the approach, each resting on a single cylinder with the exception of the out-river span, which rests on two cylinders at the out-river end. Each span consists of two precast, prestressed concrete beams of I-section.

The jetty head is being supported on three dolphins, each consisting of six cylinders approximately 70ft long—three on the out-river side and three on the inshore side. Each pair of cylinders is connected with a cast-in-situ prestressed concrete box beam 9ft wide by 8ft 6in deep by 40ft long. Each dolphin is spanned by five precast, prestressed concrete beams of I-section. The decking throughout the jetty consists of precast concrete slabs.

"Bean" bollards are being provided on the jetty head for mooring vessels. Samson posts with double derricks and electric winches are also to be used to deal with the suction hoses. Pipe-lines will be laid to headers on the jetty. The fenders, which were designed by the consultants, L. G. Mouchel and Partners, in conjunction with Thos. C. Rolland and Port and Harbour Fenders, Ltd., are horizontally suspended. There are to be six fenders in all beneath the jetty deck. They will protrude 6ft at the front and 2ft at the back of the jetty, and will be prestressed with eight cables. Each fender will be 48ft long by 7ft 6in wide by 14ft high, and capable of absorbing, by an inward and upward movement, an energy of 270 foot-tons. The contractors for constructing the jetty are John Mowlem and Co., Ltd.

Another comparatively novel form of construction was adopted during the year for the reconstruction of another marine jetty. The jetty in question was an old coal unloading wharf on the Medway belonging to Settle Speakman and Co., which stood in urgent need of reconstruction, not only to preserve it, but also to make it capable of supporting modern wharf cranes of much greater weight and capacity than those cranes with which it had been formerly equipped. The problem in this case was to maintain the old structure in effective operation while reconstruction was in progress and at the close of the reconstruction work to leave behind a greatly improved jetty equipped with much heavier and speedier plant and capable of berthing vessels of larger size than those hitherto employed. All these objects were achieved by the expedient of underpinning the old structure with steel piles. The piles themselves were made out of the new broad-flange beam rolled steel sections that have recently become available in this country. On account of the ease with which such steel sections can be handled and driven after pitching by means of a light automatic hammer clipped on to the pile itself, without any pile driving paraphernalia, the repair work was effected without any interference to the loading and unloading of ships and other wharfinger operations which were carried on upon the jetty in the normal manner all the while that the underpinning work was in progress.

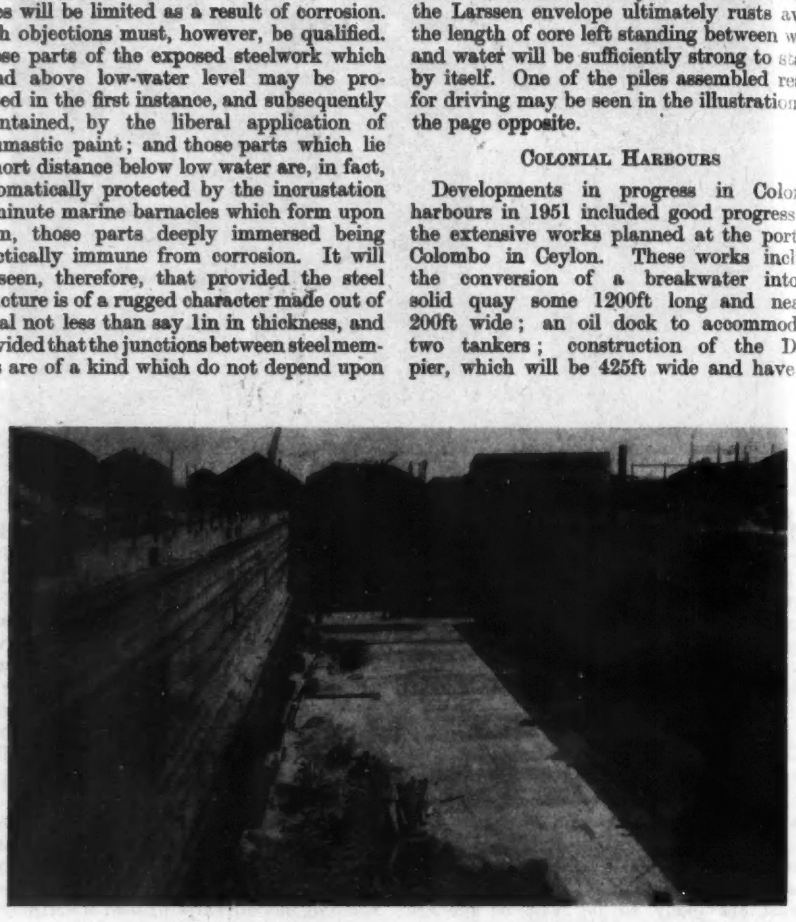
Besides the underpinning, the superstructure of the jetty was thoroughly overhauled and to a large extent rebuilt. The works were carried out by Marples Ridgway and Partners, Ltd., the consultants being Messrs. Maunsell, Posford and Pavry.

The use of bare steel in marine construction and particularly in those parts which lie between wind and water is open to the obvious criticism that the life of such structures will be limited as a result of corrosion. Such objections must, however, be qualified. Those parts of the exposed steelwork which stand above low-water level may be protected in the first instance, and subsequently maintained, by the liberal application of bitumastic paint; and those parts which lie a short distance below low water are, in fact, automatically protected by the incrustation of minute marine barnacles which form upon them, those parts deeply immersed being practically immune from corrosion. It will be seen, therefore, that provided the steel structure is of a rugged character made out of metal not less than say 1in in thickness, and provided that the junctions between steel members are of a kind which do not depend upon numbers of small bolts or rivets, the deterioration of such structures in salt water can be very largely minimised. In the Medway Jetty, mentioned above, so much care was taken to observe these conditions that the consultants confidently anticipate that the life of the steelwork will be at least equal to the life of a corresponding reinforced concrete structure and greater than might be expected if it were made of timber.

An unusual form of composite steel and concrete pile was employed by the same consulting engineers, Messrs. Maunsell, Posford and Pavry, in the design of a new wharf under construction during 1951 in the Manchester Ship Canal for the Associated Ethyl Company's new tetraethyl lead factory in Cheshire. The reasons in this case were the outcome partly of peculiar soil-mechanical properties of the basic foundation stratum encountered at the site and partly as a result of the current steel shortage. The type of pile that was employed consists of a steel shank of the well-known Larssen box pile section that was fitted out at its lower end with a relatively enormous concrete point. The large size of the concrete point is required to give the requisite bearing area in the weak stratum at the bottom of the ship canal, and the steel box pile shank is required in order to stand, without damage, the very heavy driving punishment that must be delivered in order to get the point well embedded. Deep penetration is not sought because the strata deteriorate with depth. The composite pile constitutes the most economical solution for these particular foundations, where the loading conditions happen to be exceptionally severe. The box pile shank of the pile is in this case filled with reinforced concrete, so that if nearly all the steelwork of the Larssen envelope ultimately rusts away the length of core left standing between wind and water will be sufficiently strong to stand by itself. One of the piles assembled ready for driving may be seen in the illustration on the page opposite.

Colonial Harbours

Developments in progress in Colonial harbours in 1951 included good progress on the extensive works planned at the port of Colombo in Ceylon. These works include the conversion of a breakwater into a solid quay some 1200ft long and nearly 200ft wide; an oil dock to accommodate two tankers; construction of the Delft pier, which will be 425ft wide and have an east and a west quay each over 1000ft in length; and a second breakwater quay, 3000ft long and 400ft wide. The consulting engineers for this work are Messrs. Coode, Vaughan-Lee, Frank and Gwyther, and the contractors the Cie Industrielle des Travaux, and Etablissements Billiard.



Progress of Reconstructed Dry Dock at Sunderland

Other large harbour works in progress in the colonies in 1951 included the extensions of the Apapa Wharf at Lagos, Nigeria, for which the consultants mentioned above are responsible, and extensions to Takoradi Harbour on the Gold Coast, which are being constructed under the direction of Messrs. Rendel, Palmer and Tritton. Another work of about the same magnitude as those mentioned above is that at Chittagong, in East Pakistan, which is described below in greater detail.

Chittagong Port Development

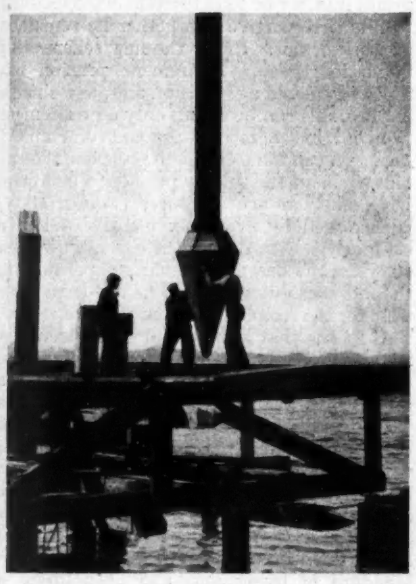
In December, 1950, the Government of Pakistan placed a contract with Braithwaite and Co., Engineers, Ltd., for the construction at the port of Chittagong, E. Pakistan, of seven new steamer wharves (known locally as jetties) at a cost of nearly £2½ million, the time for completion being thirty-four months. The new jetties, situated about 10 miles up the Karnafuli River, will form an extension of 4000 lineal feet to the existing wharfage and will provide a depth of water alongside of about 30ft at low tide. This work will constitute a large part of the first stage of the full development plan for the Port of

Chittagong drawn up by the consulting engineers, Messrs. Merz Rendel Vatten (Pakistan).

As in the case of the existing jetties, the new jetty structure will be of steel screw pile construction; 7in diameter solid steel piles with 5ft diameter cast steel screws will be screwed at 15ft centres about 30ft into the river bed, which consists of varying depths of clay, silt or sand or admixtures of all three. The front four bays of the piling will be braced to 12ft below low water and the piles will support transverse beams on which longitudinal deck beams will rest. The decking will be of mass concrete in the form of jack arches between the deck beams.

The contractor's special plant for the erection of these jetties will enable eight piles in each bent to be screwed through a frame with the rig in one position; where more than eight are required in a bent, further piles will be screwed by individual electric capstans. Immediately behind the screwing frame, cages of pre-assembled bracing will be lowered and fixed by divers, and the whole piling rig moved forward over the completed pile structure. The placing of deck steelwork and the concreting of the jetty deck, together with the laying of railway and crane tracks, will follow consecutively behind the piling rig. The illustration herewith shows the contractor's model of the piling rig and jetty structure.

All the structural steelwork, specified to be of 0·35 to 0·50 per cent copper bearing steel (B.S. 15 quality 2*b*) is being manufactured and fabricated in this country and shipments of materials to Chittagong were being made in 1951. The erection of the jetties is expected to commence early this year. The Government of Pakistan also let



COMPOSITE STEEL AND CONCRETE PILE

a contract recently for the manufacture by Kampnagel A/G Hamburg, Germany, of twenty-nine 3-ton electric portal quay cranes for use on the new jetties. These are travelling cranes for handling general cargo and will have a maximum radius of 63ft 6in. Supervision of this work is being carried out by Messrs. Rendel, Palmer and Tritton, one of the member firms of Messrs. Merz Rendel Vatten (Pakistan).

Wharf at Bathurst, Gambia

Another work which we propose to mention is the recently completed reconstruction of the Government of Gambia's wharf at Bathurst in West Africa. Although on a much smaller scale than the developments in the preceding paragraphs, the work was noteworthy on account of the form of construction adopted. The sub-soil everywhere in the proximity of the town appeared to be composed of fine mud or silt, so that in forming a deep-water wharf or jetty the problem was to find a type of foundation which would offer the requisite degree of strength and stability. The solution selected was the use of cylindrical precast concrete piles of hollow form called "caisson piles" to distinguish them from the ordinary variety of precast concrete piles. Their external diameter was 3ft and the internal diameter 2ft 3in, the length 75ft and the weight of each caisson pile about 13 tons.

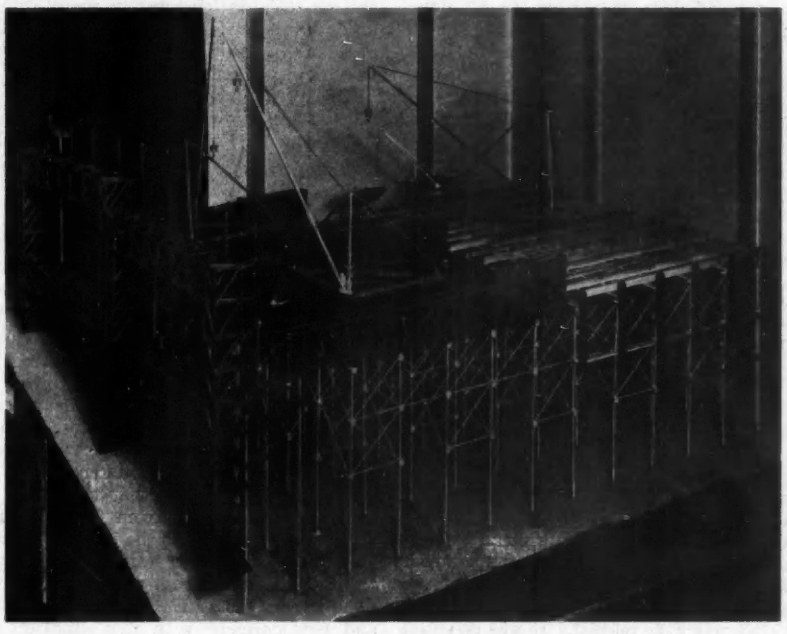
The piles were so light that they would float in water with a little exterior support, so that after they had been precast on shore by native labour they were rolled into the water and floated out to the place where they were to be pitched and driven. Driving was through strata composed of fine sand and silt to depths of between 25ft and 40ft, with the help of a water jet and of a 4-ton hammer operated inside the pile shank and striking light blows on the foot of the pile within the hollow shank. Another peculiarity of this method of driving was the fact that the hammer working inside the pile was itself operating not in air but in water.

The piles being of large size, presented a large bottom area and also a large skin frictional area to the soft strata in which they were embedded. Some of them were driven on the slant, it being almost as easy on this system to drive raking piles as it was to drive upright piles. The function of the raking piles was to impart lateral stability to the structure, so obviating the necessity of introducing lateral underwater bracings between piles. The piles themselves with their perfectly smooth, cylindrical exterior forms, offer a minimum resistance to the motion of waves and currents and the reinforcing rods in the pile shanks are protected against corrosion by an external cover of 2in of concrete. The concrete itself was composed of the best concrete aggregate imported from England. This was done because no material out of which to make concrete of first-class quality was obtainable in the Gambia.

It will be seen, therefore, that these caisson piles, with their large cross-sectional area, driven at various inclinations were capable of standing up in 40ft of water without cross bracing to form, with the interconnecting concrete deck slab, a self-braced structure; and that on account of their large superficial area they provided at the same time a type of foundation underground which was capable of deriving the requisite support from weak surrounding strata. The consulting engineers for the wharf at Bathurst were Messrs. Maunsell, Posford and Pavry, and the contractors were Caffin and Co., Ltd.

It will be evident from many of the foregoing examples that there is still a great deal of scope in civil engineering to develop novel forms of structure adapted for the sake of convenience or for economy in special circumstances. In some of the more unusual instances described in this article it was not only a question of designing something more effective or more economical, but of devising new methods whereby the new form of construction could be built. The design of the new constructional form has in such cases to go forward *pari passu* with the planning of how the thing is to be practically performed. The design and the method of construction have to go hand in hand and the would-be innovator must, in order to make a success of the innovation, be able to foresee and provide in advance against contingencies of many kinds.

(To be continued.)



MODEL OF PILING RIG FOR CHITTAGONG PORT

Owen Falls Power Scheme.—The Owen Falls Power Scheme in Uganda, the progress of which was described in our issue of December 28, 1951, when complete, will supply 150,000kW. For the construction of these works a considerable amount of electrical power is required and to provide this Hurland and Wolff, Ltd., have supplied fifteen diesel alternator sets having a total output of 14,000kW. Four engines were installed at the Kampala and eleven engines at the Njeru generating stations. All the engines, which are of the maker's standard size, are equipped with a Buchi blower and have a standard rating of 1580 b.h.p. at 333 r.p.m., while each alternator has a site output of 940kW.

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Labour in 1951

By GERTRUDE WILLIAMS

No. II—(*Concluded from page 15, January 4th*)

Dock Labour

IN recent years no industry has given more evidence of the lack of contact between union leaders and the rank and file than the docks; so much so, in fact, as seriously to endanger the great scheme for the decasualisation of dock labour which was set up at the end of the war. Ever since the eighties of the last century efforts have been made to introduce a measure of regularity into dockers' earnings, but until the war without any success. Dock workers were taken on for a half-day shift without any guarantee that a man would have the chance to work any minimum number of shifts a week, even though there was work to be done. He might get six days' work one week, none the next, and a couple in the one following that. This was not due to the cussedness of either employer or worker, but to the irregularity which is part of the nature of dock work. The employer has very little control over the amount of work that needs doing on any particular day. The number of ships using a port depends on the quantity and kind of international trade, and a storm at sea or a strike in a foreign port may delay the arrival of an expected ship and lessen the amount of work that is available on that day. It would have been very expensive to maintain a large body of permanent workers on the pay roll when it was easy enough to take on the number required from the large number waiting for work when the need arose. The war increased the irregularity of work, for a port might be bombed and put out of action temporarily, or ships be sunk at sea or so damaged that they were forced to limp into the nearest harbour instead of making for their original destination; but the acute shortage of manpower made it impossible to leave a large supply of workers at every port on the offchance that they might be needed. It was essential to economise labour by organising dock workers into a coherent group whose members might be allocated to different docks as they were required. After a difficult start the scheme introduced to do this proved sufficiently successful to be retained after the war and, by the Dock Workers (Regulation of Employment) Order, 1947, the present Dock Labour Scheme was established.

The scheme is administered by the National Dock Labour Board and by local boards in each port or group of ports. The National Board consists of an independent chairman and vice-chairman and eight members, four of whom are chosen to represent dock employers and four to represent dock workers. The local boards have no independent members and are composed of equal numbers of employers and workers. Thus, the main control of the scheme is vested jointly in the employers and the unions.

Employment in the docks is limited to registered workers and only registered employers may employ them. Wages are fixed as before by collective agreement between employers and workers, usually on a piecework basis, but every worker on the register has a right to a guaranteed weekly minimum wage, irrespective of whether he actually works the number of shifts represented by this minimum or not. In return, he must be available for work at the required times and places. On each shift he can first try to get work with the employer of his choice, but, if he fails, he must report to the local board and is allocated to any employer who is in need of further workers. The funds for the guaranteed wage are provided by the employers on the basis of a percentage of their wages bill. The scheme is based on the fact that the amount of work available in a port as a whole is much more stable than the amount that can be offered by any individual employer. In the Port of London, for example, there are about 470 separate employers employing a total of some 28,000 dock workers. The employers range in size from one which normally employs as many as 4000 to many who employ only a handful, and as they are engaged in many different kinds of trade it is highly unlikely that all of them will be either very busy or very short of work on the same day.

The great advantages afforded by the scheme are obvious and are well recognised by the men. For the first time they have complete security of employment in peacetime. But whilst probably none of them would want to go back to the bad old days, there has been some difficulty in realising that the new system imposes certain duties for the rights it confers. Many look back with some nostalgia to the time when they felt free to take a day off without anybody questioning them, whenever they thought they had earned enough to keep going for a bit or to go to the hopfields or other such seasonal work, for a change of air and scene. Disciplinary action against those who fail to offer themselves for work or to go where they are allocated can be taken by the local board, but this means that the men's own union representatives seem to have turned against them and to be siding with the employers, instead of standing up for them through thick and thin as they had always done in the past. The feelings of irritation and bewilderment with this situation have given many golden opportunities to "unofficial" leaders, with the result that the docks have been the scene of an exceptionally large number of strikes, many of which seem, to the outsider, to have the flimsiest of justifications.

The committee of enquiry, set up by the Ministry of Labour under the chairmanship of Sir Frederick Leggett to investigate the unofficial stoppages in the London Docks, came to the conclusion that, unless effective measures could be taken to prevent this unconstitutional action, the scheme could not continue to function and recommended that the anomalous position of the trade union members of the Dock Labour Board should be altered, by removing responsibility for discipline from the Board altogether. At present it often happens that a dock worker, who has appealed to a tribunal against disciplinary action, has his case put by a trade union official, whilst other members of the same union are sitting as members of the tribunal which may reject the appeal. It does not make sense to him. At the same time, the committee felt that the unions had failed in their duty to make clear to their members the change in the situation. The great size of the unions gave local groups the feeling that they had no channel of communication whereby their peculiar problems might be put before their leaders and they turned to "the man on the spot," who was thus able to exploit a local grievance.

Manpower and Rearmament

With the increasing speed in the development of the rearmament programme the manpower problem has become acute. Sir Walter Monckton, the Minister of Labour, recently spoke of there being over 400,000 vacancies unfilled and, as the unemployment figure has fluctuated for years between the low levels of 1·0 and 1·5 per cent, it is obvious that there is no reserve on which to draw. Even this does not give the true seriousness of the position. It is estimated that the aircraft and Royal Ordnance factories will need a further 175,000 employees in the near future; they can only be made available if employment in non-essential industries is drastically curtailed. A Cabinet Committee is discussing the situation and there have even been suggestions that control of engagements might once again have to be imposed.

In these circumstances the results of two recent inquiries are of exceptional interest—one made by the Ministry of National Insurance and published in its latest report; the other made by a group of industrial psychologists, working under the general direction of Sir F. C. Bartlett. Both are concerned with the employment possibilities of those in the older age groups.

Retirement Age

The National Insurance Act, 1946, changed the conditions under which men and women reaching pensionable ages can draw benefit, with the aim of persuading people to stay at work as long as possible. Under the old scheme the contributory old age pension was a statutory right for the man who reached the age of sixty-five (women sixty) if the appropriate number of contributions were credited to him, irrespective of whether he remained at work or not. Under the new scheme this is no longer so. Retirement pension has replaced the old age pension and, as its name implies, this can be drawn only on retirement from all but a modest amount of employment. As an inducement to postpone the age of retirement the weekly pension, which may be claimed at age sixty-five (women sixty) is increased by every six months' delay in claiming it. At the age of seventy (women sixty-five) it becomes an old age pension, in the old sense of the term, i.e., it is payable whether the recipient stays at work or retires. This means that a man who could have got 26s. a week if he gave up work at sixty-five could, by continuing in employment for a further five years, ultimately receive 36s. a week for the remainder of his life (with, of course, an additional 16s. a week for his wife). The National Insurance Act passed last year has made further changes to strengthen the inducement to older people to stay at work. With the rise in the cost of living 26s. does not represent the basic standard of living that had been intended when the Act was originally passed, and this sum was accordingly raised to 30s. (with a similar rise in the wife's allowance from 16s. to 20s.), but only for those who are seventy or over (women sixty-five or over). For those between sixty-five and seventy (women sixty and sixty-five) who retire from employment the pension remains at the old rate.

The changing age composition of the population, particularly during the last half-century, has thrown into prominence the whole problem of the position of the older groups in our economy. Since the end of the nineteenth century the birth-rate has gone down very rapidly. In the early seventies it was thirty-five, which means that there were thirty-five children born for every 1000 persons in the population;

but from then it began to decline until it reached its lowest level of fourteen to fifteen during the 'thirties. It rose appreciably at the end of the war and the years immediately following, as is generally to be expected, and has now once again begun to fall, though not to the low level of the depression years. At the same time, the expectation of life has been increased by better food and housing, more medical knowledge and the opportunity for a larger proportion of the community to get medical advice and assistance. The consequence of this is that the older age groups in the population have become larger and larger in proportion to the others. With the decline in the death-rates a much larger number of those who were born when the birth-rate was high sixty, seventy and eighty years ago are still alive, but smaller numbers have been born to recruit the younger age groups who take their place as the productive workers. At the beginning of the century there were ten people over present pensionable ages for every hundred younger people of working age; at present there are twenty and in less than a generation there will be thirty.

The age of retirement has to be looked at in the light of these figures. Every year's delay in giving up work has a double significance; it adds to the number of people producing wealth and it reduces the burden of the cost of maintaining those who are no longer effective producers. Unfortunately, however, the system of provision for the elderly developed mainly during the prolonged period of depression when mass unemployment was the dominant factor in our economic situation. The general feeling then was that older workers should be encouraged to retire so as to leave more jobs available for those in the prime of life and the age of sixty-five came to be firmly fixed in the minds of most people as the "right" age for giving up employment. It is proving very difficult to change this belief, despite the existing opportunities for regular employment at good wages and despite the offer of higher pensions at a later age.

The Ministry of National Insurance has recently completed a sample inquiry to discover how many people stay on at work after reaching pensionable age and how long they continue to do so. The changes in provision that were introduced in the Act of 1951 are, of course, too recent to have yet had any effects that can be calculated, so the inquiry relates to the effects of the retirement pensions, with their possibilities of increment, that became available in 1948. This shows that roughly 60 per cent of men and 47 per cent of women were still in employment a month after they had reached the ages at which they had the legal right to begin to draw pensions; but month by month after that the percentage dropped. Eighteen months after pensionable age only 45 per cent of men and 33 per cent of women were still in employment.

This is unfortunate from every point of view. The length of life has increased so much in this century that a man of sixty-five now has an expectation of nearly thirteen more years of life and a woman of sixty of nearly nineteen more. For a rapidly increasing proportion of the population to be maintained out of public funds for such long periods means that, either the level of their maintenance must be kept so low as to make the prospect of old age a nightmare, or that the burden on the younger age groups must become so heavy as to compel them to limit still further the number of their own children in order to be able to meet their contribution to the support of the old.

But this is not the only consideration. It is only in recent years that we have begun to appreciate the extent to which both physical and mental health depend upon living as full and active a life as one's capacities permit. Time was when it was thought to be the duty of younger people to do everything they could to help the old to sit back with folded hands and enjoy the period of rest that their earlier work had earned for them. The new science of geriatrics is proving that this was literally "killing by kindness," for the more passively older persons live their lives, the more rapid the onset of senility and decay. Psychological factors probably play the most important part in this relationship. Nothing is as deadly as boredom, and few persons have such resources within themselves or such strongly marked interests and hobbies that they can easily fill the whole day with enjoyable activity or meditation. But even more destructive is the sense of being "finished with life," of having no real niche to fill in the world, of not being needed. In this respect most old women have an easier time than men. There is no great dividing line in their lives between work and retirement, even for the minority who have been in paid employment, for most of them have also had to busy themselves with cooking and cleaning and making and mending clothes. These jobs go on for ever, and no woman thinks of giving them up completely until she is actually compelled to by physical incapacity. She need never be in danger of finding herself unwanted, for, in these days, the woman who can lend a hand, even if not a very strong hand, with domestic chores and with minding young children, can always be sure of a welcome. So there is no very definite moment in a woman's life when she has to make a comprehensive adjustment to an entirely new pattern of existence. With a man it is different. There comes a moment when he retires from his job and his whole life has to be rearranged. The more he has identified himself with his work and has thrown into it all his energies, the less fitted he is to adapt himself to the new life and he quickly becomes ill and unhappy and, indeed, finds himself, though he does not always recognise the cause, slowly dying from sheer boredom. It is a known fact that women live longer than men. The higher the age group the larger the proportion of women to men, until in the oldest group of all, those over eighty, the proportion is two women to every man. There is, of course, no simple explanation of this fact, which is the result of many complex constituents; but Dr. J. H. Sheldon, who made an important investigation into the social medicine of old age in Wolverhampton, puts forward as, at least, an important element in the situation this marked difference in the continued occupation of men and women in old age.

"Skill and Age"

From the point of view of their own health and happiness, therefore, people should be encouraged to continue an active life of employment as long as they can. But the question at once arises: "Is it possible for them to continue in their customary industrial jobs? Granted that some occupation is advisable, is it not necessary to transfer them to light jobs which will not make so much strain on them as the work they did in the ordinary course of their working lives?" It is in connection with this question that the second inquiry of which mention was made above is particularly interesting. The results of the inquiry, published by the Nuffield Foundation in a report called "Skill and Age," are, as the authors of the report continually insist, still experimental. This is the first time that an attempt has been made to study the changes brought about by advancing years in relation to industrial work, and many more similar studies will have to be made before the results can be considered definite. But enough has been done to bring out certain very striking probabilities and to show that many of our preconceptions are probably unfounded. For example, there is a widely held view that older people should be moved from heavy work to lighter. This inquiry seems to point to an exactly opposite conclusion. Whilst very heavy strenuous work is unsuitable to most older people, moderately heavy operations are well within their capacity, particularly if the strain is not continuous. It is much more difficult for old people to maintain a continuous rapid action and this is a usual feature of lighter operations.

Two other results of the inquiry are worth mentioning. First, the evidence collected shows that older people, even if slower, are more careful than younger ones and are thus suitable for operations demanding a high degree of accuracy. Secondly, it is very much easier for people of middle and old age to maintain skill than to acquire it. If changes in technique, therefore, have to be introduced or if older workers have to change their jobs, the methods of retraining are of the greatest importance, particularly in order to consider how far the characteristic features or "elements" of an old skill can be transferred to the new.

There are, of course, many problems of organisation to be solved if full use is to be made of older workers. Many might be presuaded to work part time, but feel incapable or unwilling to continue the full working day or week. During the war, when millions of men and women had to be released from employment for the Services, firms were compelled to replan so as to make use of the part-time labour of married women or else to shut down. The same necessity is before us now, not only to employ women who can spare part of the week from their domestic duties, but even more to make use of the rapidly growing battalions of the elderly.

New Plans for Oil Refineries in Australia

Refining of oil in Australia has assumed a rapidly increasing importance, not only because of international conditions and defence precautions, but also in great measure because of ever-expanding local demand; consumption of petrol in the Commonwealth is now about 1½ million gallons daily. Latest development is the application of the Caltex Oil Company for Federal Government approval for the erection of a £25,000,000 oil refinery with a predicted output of about half a million gallons of petrol a day, as well as resultant products. The site of the refinery, which will be able to treat a big range of crudes, has not yet been determined. At present the Commonwealth has three refineries producing petrol from crude oil and a costly and now moribund shale oil refinery which was run by the Federal Government at Glen Davis in N.S.W. and which is to be closed down. It is intended that the retorting plant be shifted to the aluminium works in Tasmania. The three flourishing enterprises are those of the Shell Company, at Clyde, N.S.W., and of the Vacuum Oil Company and the Commonwealth Oil Refineries, Ltd., respectively, both in Victoria. The Shell Company is also building a new refinery at Geelong, Victoria.

Thread Measuring Parallels.—Some years ago W. H. Marley and Co., Ltd., 105, High Road, London, N.11, introduced a range of useful measuring parallels for the effective diameter of screw threads. We are informed by the company that these parallels are now available for the measurement of unified screw threads, from 4 to 44 threads per inch.

The Royal Navy, 1951

(By Our Naval Correspondent)

No. II—*(Concluded from page 9, January 4th)*

Naval Aviation

ALTHOUGH the Royal Navy devotes nearly a quarter of its manpower and one-third of its budget directly or indirectly to aviation, it is only now that it is beginning to replace piston engine aircraft with jet machines of the latest types. The first operational squadron of naval jet aircraft—eight Supermarine "Attacker F.I." single-seater jet fighters—is to be embarked in the "Eagle" for fleet defence. The "Attacker," which is regarded as an interim fighter, will later be supplemented and eventually replaced by the "Sea Hawk." Another modern aircraft now in quantity production for the Navy is the de Havilland "Sea Venom," an all-weather two-seater turbo-jet fighter for day and night use. These three aircraft should provide the Navy with a fighter defence capable of dealing with any enemy land-based fighters, but still better and more powerful

VICKERS "508" TWIN JET NAVAL FIGHTER

machines will soon be in production. The twin jet engine Supermarine 508, recently taken off the secret list, is claimed to be the fastest and most powerful naval fighter in the world. In spite of its high performance, the landing speed has been kept down within the requirements for carrier-borne operations by the use of special lift devices on its thin wings. Westland "Wyverns" will shortly be available as the Navy's strike fighter and the Fairey 17 for locating and attacking submarines. The latter are powered by an Armstrong-Siddeley Double Mamba airscrew-turbine engine and are the first aircraft to be designed specifically for anti-submarine operations. The helicopter is also being developed for anti-submarine work, operating from a small platform fitted in merchant ships. A new R.N.V.R. anti-submarine air squadron has now been formed, making five R.N.V.R. squadrons in all—two anti-submarine squadrons equipped with "Fireflies" and three fighter squadrons with "Seafires" and "Seafuries." These piston-engined aircraft have done splendid work in the Korean campaign, operating from the light fleet carriers "Theseus," "Glory," and, more recently, from the Royal Australian carrier "Sydney."

The urgent problem at the moment is the shortage of pilots and observers, due partly to the old machines which the Navy has had to operate since the war, but also to the poor career prospects offered to pilots with short service commissions. There are at present four schemes in force for providing officers for the Naval Air Branch :—

(1) The regular naval officer who elects to specialise in flying.

(2) Former naval pilots and observers under thirty-three years, who may enter for periods of from four to eight years, followed by varying periods of reserve service on the Emergency List.

(3) Young men without flying experience, who enter for short service commissions of eight years, with a gratuity of £1500 unless selected for a permanent commission.

(4) National Servicemen volunteering for a further two years' service and subsequently for an additional period of four years, making eight years in all, with a gratuity varying according to length of service.

It would clearly be impracticable—and unfair to the regular personnel—to offer long service commissions to all these officers, but there would no doubt be more volunteers if their flying careers could be extended by temporary transfer to Coastal Command, which would find the influx of experienced pilots, trained in warship recognition and reconnaissance work, a valuable asset and an economy.

Supreme Commander, Atlantic

Mr. Attlee's announcement almost a year ago of the proposed appointment of an American admiral as Supreme Commander, Atlantic, caused surprise and dismay throughout the country and two heated Parliamentary debates. Mr. Churchill argued that the overwhelming weight of British naval opinion was opposed to the appointment of a supreme commander, and quoted in support the views of admirals of the Fleet Viscount Cunningham and Lord Tovey and Admiral Sir Percy Noble, all of whom were closely concerned in the U-boat battle during the last war. He would prefer the command of the Mediterranean to be given to the Americans, for which there were sound practical, strategical and political reasons. Although the United States has taken our place as the greatest naval power, there can be no doubt that we have the preponderance of merchant shipping and are capable of a far greater and more rapid expansion in the naval sphere than almost any other nation. Fortunately, according to a statement early in October by the Secretary of the United States Navy, a decision on this question, which is of such great importance to the safety and prestige of this country, was deferred, pending the results of the General Election.

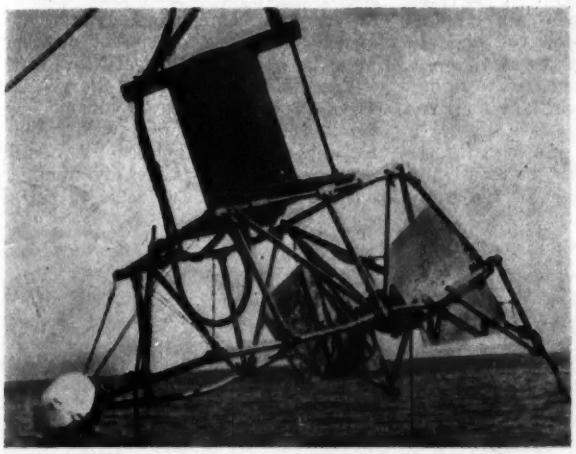
Maintenance

The Royal Dockyards are now fully occupied in refitting, modernising and converting H.M. ships. Almost all the new construction under the rearmament programme, together with a good deal of the conversion work, has been given to private yards. In all, some sixty ships of the reserve fleet will have been brought forward for service in the active fleet, in the training squadron or for trials during this financial year, including a light fleet carrier, two fast minelayers, three destroyers, five frigates, thirty minesweepers and three submarines. Good progress has been made in the provision of war equipment for merchant ships, including a large stock of degaussing (anti-magnetic mine) material. Sufficient numbers of dual-purpose weapons for arming the entire Merchant Navy in an emergency have already been acquired and distributed throughout the United Kingdom and the Commonwealth, together with large quantities of auxiliary equipment. Defence courses have also been started for the Merchant Navy in London, Liverpool, Glasgow and Newcastle, with the object of familiarising officers and men with the measures required for the protection of the Merchant Navy in time of war. Reserves of stores of all kinds necessary for placing the Fleet on a war footing are being accumulated, and a substantial proportion of our requirements are now available. They include clothing and other victualling stores, medical stores, ammunition, engineering spare parts, general naval maintenance stores and oil fuel. Considerable economy has been effected by reducing the great variety of similar stores, and there is continuing progress in the standardisation of material in use within the Navy.

In accordance with the agreement in 1950 between the United States, British and Canadian navies, to endeavour to arrive at common doctrines and methods in the conduct of naval operations, discussions have continued on the development of common designs and standardisation in equipment and training methods. There is, however, as yet little official information of practical results, apart from the statement by the Canadian Deputy Defence Minister that it has been agreed to adopt the United States 3in anti-aircraft gun. But a common specification has now been laid down for all fuels used by ships, thus permitting common refuelling at sea, and agreement has been reached on types of electrical power which makes it possible to transfer equipment to ships of the other navies. All N.A.T.O. navies will also soon be using a common system of signals for communications and manœuvring.

Following the further explosion of ammunition in the "Bedenham," at Gibraltar, the First Lord again emphasised that there was no evidence of organised sabotage in the Armed Forces. Most of the incidents which had occurred in the Royal Navy had consisted of malicious damage inspired by petty spite or individual grievances. Apart from the two explosions at Gosport and Gibraltar, any damage done had usually been slight. The explosion in the "Bedenham" appeared to have been due to the ignition of a depth charge in a lighter moored alongside the vessel. The resulting fire caused the ammunition in the lighter to explode and the force of the explosion broke the "Bedenham" in two.

Some progress has been made in the construction of married quarters and the modernisation of the Royal Naval and Royal Marine barracks. Additional Royal Naval Air Stations are being brought into service, and the runways at existing stations are being extended to facilitate the operation of jet aircraft. The White Ensign was hauled down for the last time at Bermuda Naval Dockyard on March 31st, in accordance with the decision to close the dockyard and refit ships of the American and West Indies Squadron at the Home dockyards. The squadron will, however, continue to use Bermuda as its headquarters.



UNDERWATER TELEVISION RIG

Research, Development and Trials

Although expenditure on naval research and development has been increasing year by year, research is still mainly directed to the investigation of counter-measures against the various forms of high-speed attack to be expected in the future from high-speed jet aircraft, high-speed missiles and submarines with high under-water speed. The development of offensive weapons—guided missiles and atomic weapons—and the construction of prototype craft to use them—have in general been left to the United States Navy. This is clearly the right policy in view of the much greater resources of the United States and of the exchange of information based on the close liaison between the two navies. It would, however, be more encouraging to the British taxpayer if we followed the United States practice of publicising some of the results achieved by research. Our official spokesmen tell us little more than that we are developing radar equipment to give increased range and speed of warning of aircraft attack and anti-submarine weapons with greater range and striking power. Obvious statements of this kind can hardly be expected to raise much interest.

The keenness of the British people to hear something of the Navy's technical progress was well illustrated by the widespread interest shown in the Admiralty announcement that the "Affray" had been identified by under-water television. In fact, much ado was made about very little, for the instrument used was merely a portable television equipment, similar to that used for outside broadcasting, placed in a water-tight container. The various remote controls for operating the set had to be designed and incorporated and the container set in a specially designed frame, together with the under-water lighting apparatus, which had been previously devised to facilitate the work of under-water photography. But these were the only "developments" from the normal broadcasting equipment. There were a large number of wrecks in the area of search, which meant that a diver had to be sent down each time an object was located by asdics, and owing to the strong current he could only operate in fine weather and for a very short period on either side of slack water. Television was thus an obvious requirement, since the range of vision of both television and diver depends on the range of underwater lighting. In its present state of development under-water television can only be of assistance to, but not a substitute for, divers.

The helicopter has already been developed for air-sea rescue work and for intercommunication between ships. Trials are now in progress to investigate the practicability of its use in anti-submarine operations. For this purpose it is intended that helicopters should operate from a small platform fitted on the stern of a merchant ship and results up to date have been promising. The Royal Navy is at present using a Westland-Sikorsky "Dragonfly," but the Americans are developing a ramjet-powered "flying windmill," which may well provide the answer to the propulsion problems of rotary-winged aircraft. Helicopters should prove particularly useful for operating with relatively slow-moving convoys, for it is now possible to detect the snort by radar—according to unofficial reports from the United States it can be detected at a distance of 8 miles. And once the submerged submarine has been located helicopters could then assist the surface vessels in destroying her by dropping sono buoys—which are much more effective than those used in the last war. These buoys are dropped in a specific pattern over the area where the presence of a submarine is suspected. Hydrophones are attached to them, which pick up the noise of the submarine's propellers and automatically transmit it to the helicopter overhead. The submarine's position can then be plotted by interpreting the relative noise level transmitted by the sonobuoys. Great hopes are also placed in the new anti-submarine equipment which locates, attacks and fires at the target automatically and will no doubt supersede the "squid," a multi-barrelled mortar which launched a pattern of depth charges ahead of the firing vessel.

Improvements in radar, electronic computers and "autopilot" techniques have given a marked stimulus to the development of guided missiles, which for the past two or three years has absorbed a very large part of the research budget of the United States fighting services. Concurrently the United States Atomic Energy Commission has been concentrating on reducing the weight of the heavy detonating mechanism of the atomic bomb. Already carrier-borne bombers are able to operate atomic bombs, and recently the chairman of the Commission announced that the United States is now in possession of tactical atomic weapons. This, in effect, means that atomic explosive can be used for rockets, torpedoes, mines and even possibly for shells, which, again, makes the firing of a large rocket—like the German "V2"—a worthwhile operation, whether launched from a surface ship or submarine. The United States has indeed developed a 12,000 lb rocket which can be guided throughout its trajectory, and this may well be the projectile for the main armament of the two rocket firing cruisers recently approved under the United States building programme.

Considerable progress has also been made in developing the smaller variety of guided rocket for defence against aircraft and submarines. The "surface-to-air" guided rocket is now in an advanced state of development in the United States and General Collins, Chief of Staff of the United States Army, has stated that these anti-aircraft rockets will be able to destroy planes at altitudes above 60,000ft. No authoritative information has been issued about anti-submarine rockets beyond the fact that the United States Navy

HELICOPTER AND LANDING MAT ON S.S. "FORT DU CANE"

has developed a shipboard launcher capable of firing them at a high rate.

The effect of guided missiles on naval operations may well be profound in the event of war within the next few years. On the one hand, ship-launched "surface-to-surface" rockets, fitted with atomic warheads, will give both surface ships and submarines vastly increased offensive power. On the other, "air-to-surface" guided missiles against surface ships make anti-aircraft defence a problem of increasing difficulty when operating in enemy waters.

Personnel

After the completion of demobilisation—which was complicated by the discharge of a large number of experienced ratings who had finished their first period during the war—it was confidently expected that the Navy would settle down to a post-war personnel strength of about 140,000. But another economic crisis in 1949–50 necessitated a further reduction to 127,500 by March 31, 1951. These plans were again upset by the Korean campaign and rearmament, and by the end of this financial year the figure will be up to 152,000. The trained personnel required are being provided by the retention of officers and men for a period of eighteen months after they are due to leave the Service and by the call-up of some 600 officers from the Emergency List of Regular Officers, the R.N.V.R. and the R.N.V. Supplementary Reserve, together with 6000 ratings from the Royal Fleet Reserve, all to serve for eighteen months. Both officers and men are joining the Navy in adequate numbers, apart from the shortage of aircrews and the lack of candidates for the Royal Corps of Naval Constructors. During 1950–51 there were no candidates for the Constructor Branch from universities or private shipbuilding firms and only three dockyard apprentices could be found with the necessary training and knowledge. Unless the pay of the Corps can be substantially increased the only solution is to embody the branch in the Navy with naval rank.

The Navy, however, in common with the other two fighting services, has been suffering since the war from a dearth of trained ratings owing to the general disinclination of men to re-engage. Before the substantial pay increases in August, 1950, about 60 per cent of ratings who had served their first period of twelve years in the Navy preferred to take up the more remunerative jobs in civil life to re-engaging for pension, and it was becoming difficult to provide trained screws even for the comparatively small number of ships in commission. Six months after the pay increases the First Lord was still reporting a shortage of petty officers, but it was at that time probably too soon to judge the effects of the increase in pay. There is certainly every reason to anticipate a very great and continuous improvement, for the present scales of pay and allowances are now as good as the wages obtainable in civil life for comparable work and skill.

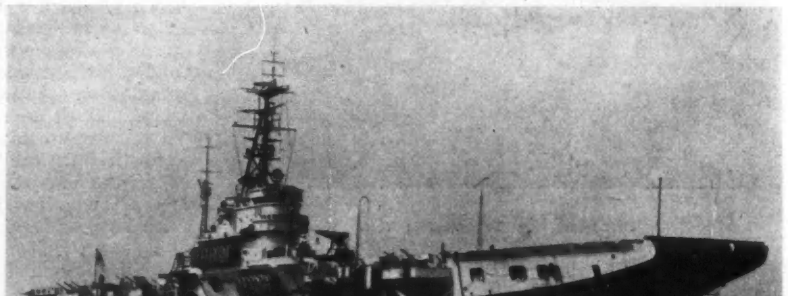
Another measure which has been taken to make the Navy still more attractive as a life career for ratings is the opportunity open to chief and petty officers to serve for a further five years—that is, twenty-seven years in all from the age of eighteen—and again (from 1953 onwards) for yet another five years, or thirty-two years in all. Finally, pensions—and this applies also to officers—have been substantially increased. For officers the increases range from £25 for lieutenant-commander's rank and below to £200 a year for a full admiral. For ratings and other ranks the improvement is in the form of a considerable increase in the element of pension earned by years of service. A chief engine-room artificer for example, now receives £4 13s. 10d. a week pension after thirty-two years' service. Moreover, the new pensions have been made more attractive by the addition of a tax-free terminal grant: £1000 for officers of all ranks and a sum, varying with rank and length of service, of from £100 to £600 for ratings and other ranks.

Provision has been made in this year's Estimates for a reserve force of 50,000 officers and men, including 25,000 fully trained men of the Royal Fleet Reserve. It is these Royal Fleet Reservists who are required immediately on mobilisation to form the crews of ships in the Reserve Fleet. Originally the force was restricted to ratings who had served in the active Navy for a full period of twelve years, but since the war it has been extended to men who served in the Navy during hostilities for at least three years. Most of the recruits for the Royal Fleet Reserve are at the moment coming from the latter category owing to the retention of time-expired men for eighteen months during the present emergency. The Royal Naval Reserve—drawn from the Merchant Navy—is considerably below strength at 4,500 officers and men, but recruits for both the Royal Naval and Royal Marine Volunteer Reserve Forces are coming in satisfactorily and these reserves are now up to a strength of 11,000 and 1500 respectively. There is also yet another Naval Reserve Force—the Royal Naval Special Reserve—which was organised, as a result of the National Service Act, for officers and men not in the R.N.V.R., who have done their compulsory service in the Navy and have subsequently to serve three years in the Reserve. There are some 8000 of these men, who are now commencing their reserve training, but the force is likely to decline in strength as re-engagements of active service ratings gradually return to normal. At the present time, however, the Navy is still able to take between 2000 and 2500 National Service men each year.

In an effort to give increased status and prestige to the Naval Reserve Forces, officers of the Royal Naval Reserve and of the Royal Naval Volunteer Reserve are in future to wear the same straight stripes and curl as regular officers of corresponding rank and branch. Until, however, they become "qualified"—and qualified status is normally only attainable in war—they will wear the letter "R" inside the curl. In the case of officers of the R.N.V.R. Air Branch, the letter "A" will be worn inside the curl instead of the letter "R." The twelve Divisions of the R.N.V.R will in future be known by ships' names and the R.N.V.R. ratings will wear the cap ribbon of the "ship" to which they belong.

Operations and Exercises

Without the assurance that they had command of the sea and could maintain it, the United Nations' forces could not have taken up the Communist challenge in Korea. It is thus very satisfactory that the Commonwealth naval forces have been able to take an adequate share in exercising that command. Deserving of special mention has been the work of the Royal Naval carriers—"Triumph," "Theseus," "Glory" and the Royal Australian Navy "Sydney"—who, in turn, operated in Korean waters and gave tactical support to the troops in addition to attacking the enemy's lines of communication and back areas. The value of carriers in oversea operations cannot be too strongly emphasised. They provide a fully equipped air base, which is able to reach the enemy's coast in a matter of days against the many weeks required to establish an air base on land. No less commendable was the work of the Commonwealth cruisers, destroyers and frigates, and of the Marine Commando unit.



LIGHT FLEET CARRIER "TRIUMPH"

The usual spring, summer and autumn cruises have been carried out by the Home and Mediterranean Fleets and every day at sea has been spent in exercises and practices. But our two main fleets are minute compared with pre-war days, when they each comprised a squadron of battleships, two cruiser squadrons, carriers and three or four flotillas of destroyers. At present the Home Fleet can only muster one battleship or fleet carrier, a light fleet carrier, two cruisers and about ten destroyers, though another carrier from the Training Squadron is normally attached for exercises. The Mediterranean Fleet is even smaller, with only a light fleet carrier, two cruisers and a few destroyers. Present-day exercises have thus to be restricted to convoy defence, anti-submarine, minesweeping and similar exercises of a simple nature.

A number of exercises of this kind have, however, been carried out in conjunction with ships of the N.A.T.O. navies, and much experience has been gained in the use of a unified system of command and a common doctrine. In one exercise in the summer, ships of no less than seven N.A.T.O. navies took part under a French admiral and another very useful exercise was carried out

in September in which ships of the British, Norwegian and Danish navies took part under the direction of Commodore Storheill, of the Royal Norwegian Navy. N.A.T.O. has now also set up its own Defence College in Paris—based on the lines of our own Imperial Defence College—fifty students drawn from the fighting and civil services of the various N.A.T.O. navies attending the courses, which last six months. Our oversea squadrons have also taken every opportunity to exercise with the Dominion Navies and useful practices have been carried out by our South Atlantic squadron operating with the South African Navy and our East Indies Squadron with the Indian, Pakistan and Ceylon navies.

Coal in 1951

By Sir R. A. S. REDMAYNE, K.C.B., M.I.C.E.

No. I

The Schuman Plan

IN the article reviewing the coal-mining industry during the year 1950, it was stated that the final report of the conference, which was to take place, was not available at the time of writing, and that the results would be awaited with interest. Readers will remember that the plan in question is one in which Belgium, Holland, Luxembourg, Germany, Italy and France are concerned, with the object of dealing with the coal, iron and steel production of these countries under a common high authority, and that the combine would be open to all other European countries to join in. The details of the proposed organisation were set out in the review article "Coal in 1950."

On February 5, 1951, it was intimated, at the Congress held in Paris, that the experts who were handling the scheme had reached agreement on all points which remained outstanding at the end of 1950.

On March 19, 1951, the draft of the Schuman Plan setting up a "European Coal and Steel Community" under a supra-national authority was agreed in Paris by the representatives of the six countries of Western Europe concerned.

As *The Times* stated in a leading article entitled "The Schuman Treaty": "It is not necessary or reasonable to suppose that the difficulties in the way of creating a single market throughout the six countries for coal, iron and steel have been entirely overcome; they have not. Ratification has to be sought in the Parliaments of the six countries where the Governments will have to justify their part in the plan on national grounds and in the teeth perhaps of strong sectional opposition from capital and labour."

Under the plan, as finally drafted, there are five institutions or organs, namely, the high authority which provides the executive, the number of its members, the method of their appointment and certain other matters are to be determined by the conference of Foreign Ministers. The authority is the agent of the six Governments jointly in regard to their present power over prices, production and investment concerning coal and steel. It is advised by a consultative committee of thirty to fifty-one members drawn in equal numbers from producers, workers, consumers and traders—a council composed of delegates from the respective Governments of the member countries which are to keep in constant touch with the authority. An assembly of delegates from national Parliaments is to be held yearly to vote upon the authority's annual report. If the assembly passes a vote of censure by a two-thirds majority—provided that those voting number at least half the total membership—the authority must resign. A special court of seven will arbitrate between the authority and all whom its decisions may concern. The court may annul decisions and order damages. All differences between members must be submitted to the court. The treaty is for fifty years. There is an interim agreement from the date when the treaty comes into force until a single market is established, in the case of coal six months and in the case of steel eight months after the treaty comes into force.

It appeared as if the "Treaty" was not going to have an easy passage through all the parliaments of the countries concerned in the plan, for the Upper House, or Bundesrat, of Western Germany, by a unanimous vote on June 27th last, recommended that before final vote on ratification was taken a binding undertaking should be obtained from the Powers concerned that the international authority for the Ruhr, the allied combined coal and steel groups, the right of the allied military security board to intervene in the industries, and the restrictions on steel capacity and production would all lapse the moment the agencies of the Schuman Plan entered on their duties, or at the latest when the common market was established.

The Government was further recommended to seek a satisfactory settlement on the so-called combined economy of coal and steel and on an economically sound agency for the sale of German coal; to have regard for the pressing investment needs of the steel industry, and to obtain a common declaration by the participating Powers that measures of the high authority would not result in a lowering of social insurance benefits or a limitation of the freedom to negotiate wage agreements.

On most of these points Ruhr industrialists and trade unionists alike feel strongly. The linking of steel works with neighbouring collieries and the retention of a central selling agency for coal were held to be vital. Under the Schuman Plan the selling agency is destined to disappear, but the German assumption was that it would survive in one form or another.

On November 22nd the International Authority of the Ruhr reached unanimous agreement, after days of debate, on future exports of German coal and an increase in prices. Dr. Pathof, the German delegate, voting for the first time with the representatives of the other Powers.

It will be interesting to see what will be the nature of the repercussions on the coal industry of the countries concerned in the plan and other countries, Great Britain in particular, should, as seems probable, the Schuman Plan become an accomplished fact in the near future. That it will have an important bearing on our coal industry, especially in respect of our export trade in coal, and in regard to iron and steel, there can be little doubt; but before joining in the plan, it would seem advisable to weigh thoroughly all possible aspects of the situation.

The German Coal Industry

The output of "black" coal from Western Germany has shown steady improvement and, towards the end of October, it was forecast that for the year 1951 it would be about 120 million tons, as against 110 million tons for the year 1950.

It must be borne in mind, too, that, apart from her "black" or true coal production, Germany is the largest individual producer of brown coal. Before the late war the annual production of brown coal was over 120 million tons; true, this coal has not a calorific value equal to that of true coal. But when converted into briquettes (approximately 3 tons of raw coal are employed in the production of 1 ton of briquettes) the calorific value is greatly enhanced. In fact, the respective values in point of calories may be stated as follows:

	Calories
True coal	7000
Brown coal	2500
Brown coal briquettes	5000

The chief brown coal deposits in Germany, from which production is forthcoming, are those in the neighbourhood of Halle and Leipzig.

The French Coal Industry

The chairman of the collieries of France, Monsieur Etienne Audibert, issued in October last a monograph on "Five Years of Coal Nationalisation." It shows a falling off in the number of miners employed in the industry. But at the same time, owing to greater use of machinery and better equipment, it indicates that the actual production of coal in 1951 will be 5 million tons better than the average production per year during the ten pre-war years, 1929 to 1938.

It was reported in the Press on February 11, 1951, that owing to the increase in the price of imported coal an inter-ministerial committee, presided over by Prime Minister Monsieur Pleven, decided that foreign anthracite and metallurgical coke should henceforth be sold at cost price, varying according to quality. There would inevitably be an increase of 10 to 15 per cent in price. This should normally affect the price of coal mined in France. According to the French Secretary of State for Economic Affairs (Monsieur Buron) the only alternative to a 12 per cent increase is a rise in State subsidies to the industry of 36,000 million francs, making a total of 40,000 million francs. It seemed likely, however, that a compromise might be effected between price increases and subsidies.

The British Coal-Mining Industry

In point of production from the mines the year 1950 did not come up to expectation for the output amounted to only 202,262,598 tons, of which 186,939,554 tons were disposable commercially, the balance being made up of mine consumption and miners' coal. The cost of production was 45s. 4·9d. per ton; proceeds amounting to 47s. 9·6d. per ton. Largely owing to the disappointing results obtained during the fourth quarter of the year, the profit did not reach expectation, amounting, as it did, to only £26,459,141, which, after all deductions, e.g., provision for compensation for loss of office, interest, loss on imported coal and profit tax, was reduced to £22,784,662, which, after the interest payable to the Ministry of Fuel and Power, left a surplus of £8,284,662.

The opening weeks of the year 1951 did not present a cheerful outlook. Lord Hyndley, the Chairman of the National Coal Board, in reviewing the state of the coal industry on February 14th, for the first time presented no forecast of the possible output for the year, but warned the public that if rearmament seriously affected manpower at collieries there might

not be as much coal produced as there was in 1950, which could mean—though he did not say so—that we should experience an even worse coal crisis during the present winter than that of last winter. Manpower had fallen, according to Lord Hyndley, by 20,000 during 1950.

According to the Parliamentary Secretary of the Ministry of Fuel and Power (Mr. Robens), speaking in the House of Commons on February 12th last, each house in the country had, on the average, received 2 tons of coal and boiler fuel, at an average cost of 90s. per ton. The average miner's house got about 10 tons at a price of 8s. 4d., excluding delivery. It was stated in the *Baltimore Sun* of February 6, 1951, that the coal which we had to purchase from America to make up our own deficiency cost an additional 15s. per ton, owing to its having to be re-shipped to Britain from Continental ports because British dock facilities are adapted especially for exporting, and not importing, coal. The Chancellor of the Exchequer (Mr. Gaitskell), speaking in the House of Commons, stated that up to January 22, 1951, the National Coal Board had spent 3,345,440 dollars (£1,195,500) on United States coal, including freightage.

As some newspapers asserted that a coal crisis was avoided during the winter of 1950–51, and one minister congratulated the public on its help in avoiding a crisis, one is tempted to ask what constitutes a coal crisis? If, having to import foreign coal in order to make good, in part, our national deficiency, cancel trains, have "blackouts" in electricity supply, low pressure in gas, and so grave a lack in domestic supply that many homes had no coal for days—because the coal merchants when applied to could only say they had no coal to deliver—if these facts do not constitute a coal crisis, what does? During sixty-seven years of active connection with the coal-mining industry the present writer cannot call to mind a winter in which there was such a dearth in coal supply as that of 1950–51. The outlook for the present winter—at the time of writing—appears, however, to be a little more propitious, as over the first forty-eight weeks of the year production was 205,511,400 tons—5,403,000 tons more than over the same period in 1950.

Financial Results

The quarterly statistics issued by the National Coal Board are, at the time of writing, only available in respect of the first three quarters, those embodied in the fourth quarterly issue will probably not appear until March of 1952. The financial results so far available are as follows :—

	First quarter £	Second quarter £	Third quarter £
Operating profit : Collieries	8,618,100	8,855,145	3,586,603
Ancillary and other commitments ...	650,000	550,000	550,000
Profit or loss after provision for interest, compensation, taxation, &c.	983,100	3,105,145	868,497 loss

In view of the figures shown in the above statement, it would appear doubtful whether the surplus profit available for 1951 will attain the £8,254,662 obtained in the previous year, owing probably to a decline in the quantity of coal exported due to low production, and increased home demand (the latter in part due to the rearmament programme), which if not met will lead to another coal crisis. Advancement in cost of production, due to meeting demands for increases in wages and enhanced price of materials, will also largely reduce profits unless the existing high prices charged for coal are still further advanced with consequential hazardous effects on industry generally. In a letter addressed to the Minister of Fuel and Power by Sir Norman Kipping, director-general of the Federation of British Industries (see *The Times* of February 10, 1951), expressing the concern of the F.B.I.'s fuel consumers' committee on the further rise in the price of coal, the writer pointed out that the added burden represented by the rise in price was equivalent to more than £50 million a year; that all British industry is founded on coal, and that the rise in price would add to costs everywhere. He added that increase in coal output per man would materially reduce, if not cancel, the need to raise from consumers this enormous sum.

In the Economic Survey for 1950 internal consumption was put at 199 million to 201 million tons per annum, so that unless production was materially increased there would be little or no coal available for export. To export coal and at the same time to have to import coal from America or elsewhere to meet home demands would appear to be a crazy policy.

Production

The output of coal at the collieries over the three quarters under review was as follows :—

	First quarter	Second quarter	Third quarter
Output in tons	53,323,361	53,184,852	48,311,315
Disposable commercially in tons	49,170,835	49,319,485	44,869,876

The output over the first two quarters showed a marked and welcome improvement compared with the like period of the previous year, and it may be that the estimate of the Minister of Fuel and Power, indicated in a speech he made at Mansfield in Nottinghamshire on October 14th last, will be realised, for he said: "Unless a disaster happens we shall get 211,000,000 tons of coal this year, an advance of 7,000,000 tons over last year." In his speech on the debate on Coal Supplies in the House of Commons on February 2, 1951, he said: "Manpower at the face is now going up and is beginning to affect the output a man-shift, which has been 1·25 tons, the highest ever recorded in this country, and 4 per cent above this time last year." But he did not indicate over what length of time this high figure had been maintained. Even if it *is* maintained for a year it will not suffice to provide an annual output sufficient to meet national internal requirements and at the same time permit of an adequate export of coal, unless there is a considerable augmentation in the number of workers employed at the collieries, and, especially, of those employed at the coal face in the actual getting of the coal and, unless, also, there is a marked reduction in absenteeism.

As *The Times*, in an admirable leading article entitled "The Coal Cut," in its issue of February 2, 1951, said: "Output a man-shift has been nearly 3½ per cent above last year—no more than might be expected with improved facilities from capital investment, and with, possibly, some concentration at present on immediate output at the cost of long-term development. Absenteeism has gone up.... The most disturbing feature of the debate, apart from the painful cut in industrial supplies—and the future climb in prices and therefore in industrial costs—was the Minister, who, while fully seized of the present dangers, remained stoutly complacent about the Government policy, in the past as well as now, for handling the affairs of this great and vital industry."

Comparative figures as to output per man-shift over periods of recent years are interesting in view of what has been stated above.

	Overall, tons	At the face, tons
For 1938, the last pre-war year, the figures were	1·14 ...	3·00
1947	1·07 ...	2·55
1948	1·11 ...	2·92
1949	1·16 ...	3·02
1950	1·19 ...	3·11

From these figures, it will be observed that with all the advance in mechanisation rendered possible owing to the improvement and the progress made in the design and construction of labour-aiding machinery applicable to coal-mining and introduced into coal-mines in recent years there has been so little advance in the quantity of coal produced per manshift by the face worker.

The total number of workers on the colliery books, which had been declining for some time at the rate of about 500 a week, was 695,100 on September 29, 1951. This, however, was a slightly better figure than that at the end of September, 1950, when it was 689,900. This matter is referred to again later on in this article.

According to Mr. Geoffrey Lloyd, the new Minister of Fuel and Power, speaking in the House of Commons on November 8th, preliminary figures for 1952 indicated a coal deficit of 4,500,000 tons or 5,500,000 tons.

Cost of Production

The cost per ton in the production of the coal raised at the collieries continued to rise during the past year. Over the last quarter of the year 1949 it was 44s. 10·1d. per ton, and over the last quarter of 1950, 46s. 0·3d. per ton, or over the whole of 1950, 45s. 4·9d. per ton. For the first three quarters of 1951 the figures have been as follows :—

Cost Per Ton of Saleable Coal

	s.	d.
First quarter, 1951	46	10·0
Second quarter, 1951	48	1·5
Third quarter, 1951	49	7·4

The advance in cost has been caused, in the main, by higher wage rates secured by the workers.

Profit per Ton—Prices and Export

The value of the proceeds per ton and the profit per ton for the past year as recorded in the quarterly statistical statements issued by the National Coal Board are given below in so far as the information is available at the time of writing, figures in respect of the fourth quarter not being yet forthcoming.

For the last quarter of 1950, with proceeds per ton at 47s. 6·6d., a profit of 1s. 6·3d. was earned, and over the whole of that year 2s. 4·7d.

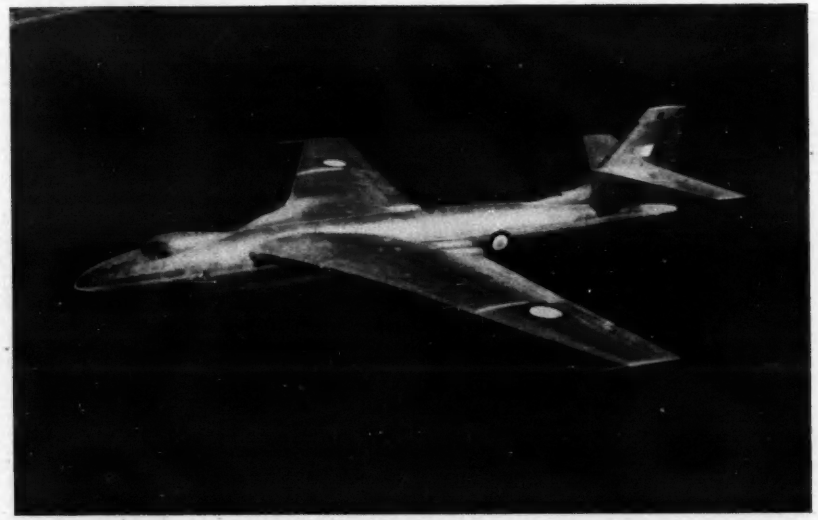
Value of Proceeds Per Ton with Profit Per Ton for the First Three Quarters of 1951

	Proceeds per ton s.	d.	Profit per ton s.	d.
First quarter, 1951 ...	50	0·8	3	2·8
Second quarter, 1951...	51	5·5	3	4·0
Third quarter, 1951 ...	51	1·2	1	5·0

It will be realised from the figures given in this review that, although the cost of production as compared with the previous year has mounted considerably, the profit per ton over the last two quarters had not suffered diminution, owing to the enhanced selling price of the coal, a condition rendered possible by the absence of competition as between colliery companies such as existed in pre-nationalisation days—a single authority can dictate selling price, a power denied to competing units.

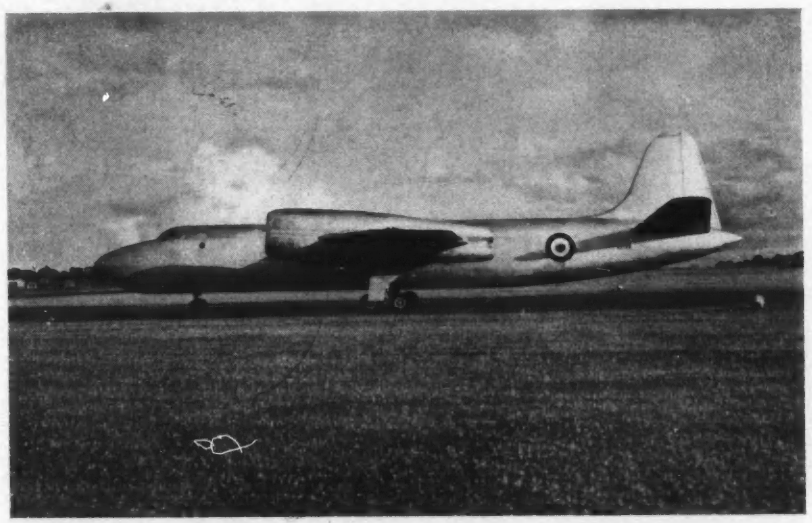
Commenting on the cut in coal supplies and the high price of coal, *The Times*, in its leading article of February 2, 1951, said: "The price of coal is to be raised, apparently, as in the war, by an equal amount every-

SOME FIGHTER AND BOMBER AIRCRAFT IN 1951



THE VICKERS "VALIANT" FOUR JET BOMBER

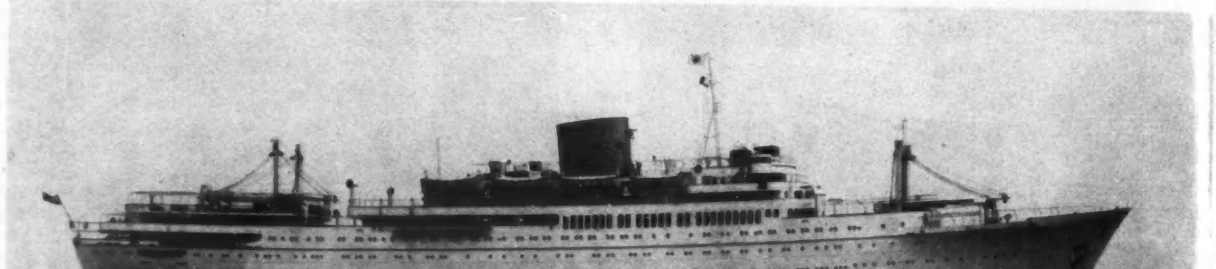
THE DE HAVILLAND "DH 110" MULTI-PURPOSE FIGHTER



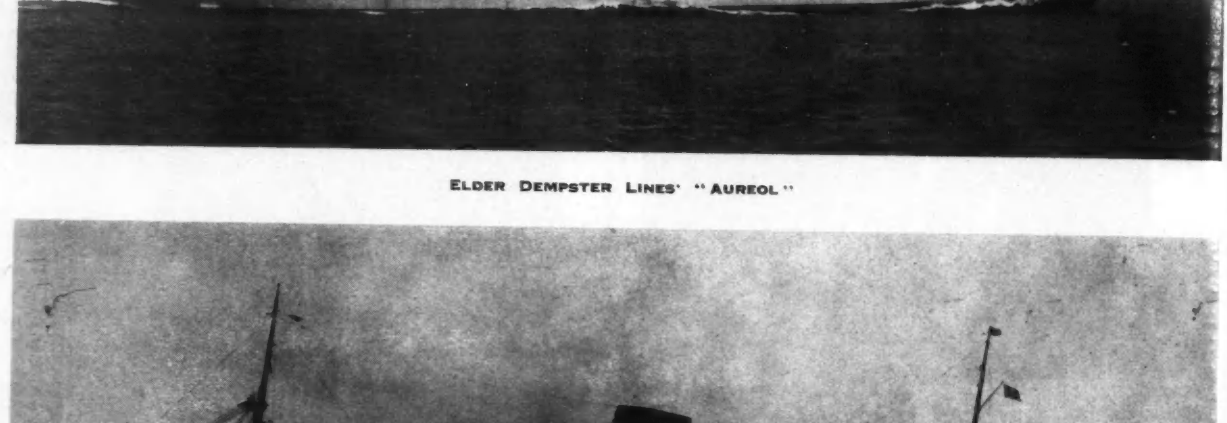
THE SHORT "SA/4" FOUR JET BOMBER

THE HAWKER "P 1067"

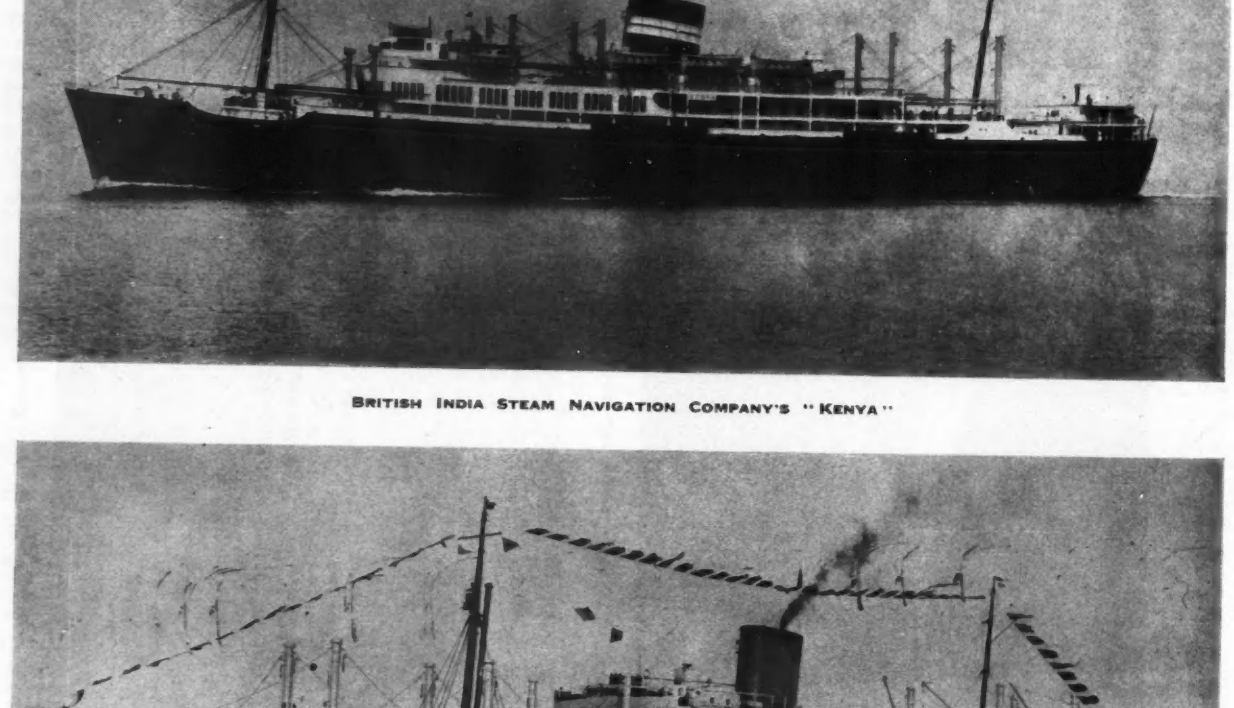
LINERS OF 1951



ELDER DEMPSTER LINES' "AUREOL"



BRITISH INDIA STEAM NAVIGATION COMPANY'S "KENYA"



NEW ZEALAND SHIPPING COMPANY'S "RUAHINE"

where. This, though it may be the right decision now, appears to be the reverse of the National Coal Board's recent attempt to relate the price of particular coals from different mining areas to their costs." On February 1, 1951, the Minister of Fuel and Power announced in the House of Commons that there would be a 15 per cent cut in coal for industry in order to safeguard the supply to power stations. The price of coal, too, was to be increased by 4s. 2d. per ton and coke by 6s. 3d. per ton, to come into force on February 5th, except in respect of household coal which would be applicable on February 12th. The cut in supply was likely to last until Easter. On the same occasion, Mr. Robens, Parliamentary Secretary to the Ministry of Fuel and Power, warned the House that we would need a production of about 235 million tons in 1952 if adequate supplies were to be assured.

The increase in the pithead price of coal meant a rise of 5 per cent in the retail price. It meant, too, an increase in the interim index of retail prices of one-fifth of one point. The price index for all other basic materials, stated the Minister, had risen during the two years by 33 per cent.

As Sir Norman Kipping stated in his letter to *The Times* of February 10, 1951: "In reverting to a flat rate increase the National Coal Board has departed from its undertaking, in future to relate the price to grade of coal," and said, "Firms that have bought plant to burn cheaper grades are thus most unfairly victimised." As has been already mentioned, the collieries earned a surplus over the first quarter of the past year of only £980,000, as against £5,600,000 over the same period in 1950, a fact, according to the Coal Board, mainly due to the cost of importing 1,200,000 tons of coal from America, the loss amounting to £3,500,000.

As to export, it is too early yet to know what is the total quantity of coal which has been sent abroad over the past year, but during the summer months the quantity was 3,600,000 tons as against 6,200,000 tons over a like period in 1950. The gravity of the present position of our coal export industry was voiced by Sir Herbert Merrett, chairman of Powell Duffryn, Ltd., speaking at the annual general meeting of that company on October 10th last, when he said: "At unbelievable cost to this country it has lost its hold on its export markets, and British-owned depôts are largely dependent upon foreign coals to earn profits taxable in this country. It would be idle to pretend that this is a passing phase." It will be remembered that the company owning the Powell Duffryn group of collieries was one of the largest, possibly the largest, exporter of coal from Great Britain.

As Mr. Alec Cairncross pointed out in his letter to *The Times* of September 21, 1951: "From the point of view of domestic needs the situation has slightly improved. But it is otherwise with exports. They have been cut in half; for every ton that we have cut, some European country will be obliged to import an equivalent amount from the United States, if it can find the ships and the dollars, at about twice the British c.i.f. price. . . . Six years after the war Western Europe is actually seeking to buy and import coal from America at the rate of over 30 million tons a year—at as high a rate, in fact, as was ever reached in the worst post-war years. It is doing so in the knowledge that, of the two principal exporting countries from which it normally buys one has cut its exports in half while the other has to be forced by an authority, on which Britain is represented, to maintain exports." And lastly, the late Chancellor of the Exchequer, Mr. Gaitskell, speaking at Nottingham on June 23rd last, emphasised the great importance of our coal exports, pointing out that if we could not supply the necessary quantity we ran the great risk of not being able to acquire essential raw materials. "Europe," he said, "is now having to import something like 20 million tons a year of American coal. Yet Europe should be our market, and from Europe in exchange for our coal we have to get iron ore, timber, butter and bacon and eggs, essential ores like tungsten for steel hardening and pyrites from which to make sulphuric acid. Everyone of these countries is putting in the forefrontof their demands from us, more coal."

(To be continued)

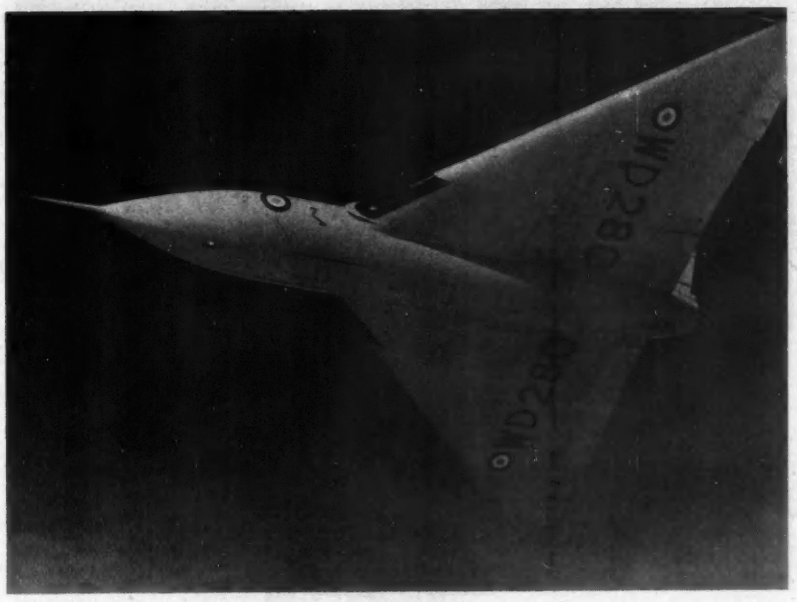
Aeronautics in 1951

No. II—*(Continued from page 31, January 4th)*

IN the first part of this review mention was made of the favourable circumstances which surround the development of civil jet and prop jet transports in this country. Production of these aircraft, however, was said to be below the demand because of the growing preoccupation of the industry with the rearmament programme. Some picture of British commitments in this sphere could quite easily be appreciated from the number of production military aircraft demonstrated at the Farnborough display.

Fighters

The latest fighters to be placed in production in this country were the Hawker "P1067" and the Vickers "Swift" machines which are illustrated. Both could be clearly identified from the prototype aircraft which each company had developed in recent years.



THE AVRO "707A" EXPERIMENTAL DELTA

Amongst other modifications, these production aircraft incorporate a single Rolls-Royce "Avon" axial-flow turbine with afterburning equipment in place of the lesser-powered "Nene" centrifugal turbine which had powered the prototypes. The higher speeds attained during the low-level runs across the aerodrome at Farnborough at this year's S.B.A.C. display aroused world-wide comment, and it was generally conceded at that time that they were comfortably in excess of 670 m.p.h., the present high-speed record. These runs were only part of a remarkable demonstration by Neville Duke of the speed and manœuvrability of the "P1067" at these altitudes. During the high-speed runs it was often difficult to register any time interval between the first hearing of the machine and its passing, whereupon the rapid succession of unusual sounds which then assailed the ear were sustained for so short a period that the effect has been largely likened to that of a whip crack. Added to the visual spectacle on the more humid days was the clearly defined vapour cloud, which enveloped the wings of the Hawker aircraft and which was significantly absent on other high-speed aircraft in the same atmosphere. This aircraft is officially stated to have a performance superior in respect of its requirements as a fighting aircraft to any other in production outside this country.

Unfortunately, the Vickers "Swift" was damaged during a forced landing just prior to the display and its immediate prototype, the "535" machine, deputised. It has, like the "P1067," fairly heavily swept main planes, rudder and tailplanes. But it is slightly shorter than that aircraft and has a larger span. Whilst little has been said of its performance, it might almost be assumed from the previous record of these two companies that there can be little to choose between the overall performance of these very important production aircraft.

Another outstanding aircraft which made its début at Farnborough last year was the Vickers Supermarine "508." It is stated by this company to be the first example of the new post-war conception of naval fighter aircraft. This machine was the first of three aircraft which first flew last year with twin Rolls-Royce "Avon" jet turbines mounted

THE GLOSTER "GA5" MULTI-PURPOSE DELTA FIGHTER

THE VICKERS "SWIFT"

THE ENGLISH ELECTRIC "CANBERRA B2"

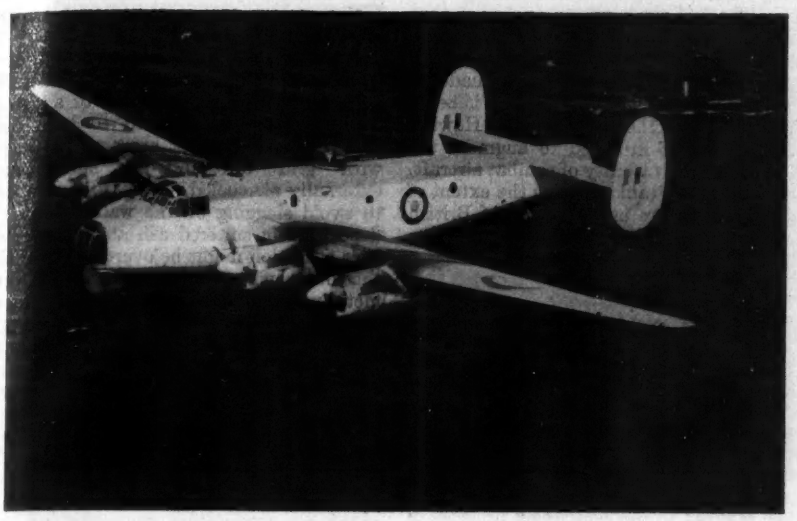
in the fuselage. In the case of the "508" it appears that the fuselage is enlarged to accommodate the engines by integral blisters which extend forward of the wing and serve also as the air intakes. It appears to employ a particularly thin wing of small area which is unswept. Despite its high performance, the landing speed is said to have been kept within the requirements for carrier operation by the use of high-lift devices associated with the leading and trailing edges. The design of the tail unit is unusual in several respects and it is the first British aircraft to mount the tailplanes with large dihedral and to be without any vertical fin. The other two aircraft mentioned, which first flew later in the year, carried the Air Ministry designation of "multi-purpose fighters," and are the first so named. Although they are radically different in conception they are believed to be designed to a single specification. The first to fly was the de Havilland "DH 110." The construction is that favoured by this company in having twin booms carrying the horizontal tailplane well clear of the wing wake. The rudders appear to be incorporated at the upsweep of the boom ends. It has a thin wing, highly swept and tapered with deepened root sections carrying the air intakes. Boundary layer fences are fitted, a device adapted by this company on most of its swept wing designs. Our illustration reproduced in plate I was said to be taken after sunset on its second test flight.

The other multi-purpose fighter the "GA5," as illustrated on this page, has a delta configuration. It is made by the Gloster Aircraft Company and its two jet turbines are "Sapphire" axial-flow units made by Armstrong Siddeley Motors, Ltd. Both these companies are members of the Hawker Siddeley Group, as is the A.V. Roe and Co., Ltd., which has been outspoken in its praise of delta flying characteristics as a result of experience with the Avro "707A" and "707B" delta aircraft, which are both tailless versions. This is the first known aircraft to be designed for the "Sapphire" engine, which is still the most powerful turbo-jet in production in this country. Twin units are mounted partly in the fuselage and probably reach into the wing root ahead of which are the fuselage blisters associated with the installation and the air intakes.

It was perhaps one of the more significant developments of the year that a specific military aircraft should have appeared with a delta plan form. Particularly was this so as it is a fighter aircraft, and the company have explained that the engineering and aerodynamic properties of the delta would be more profitably combined in the design of larger high-speed bomber or transport aircraft.

Both the "GA5" and the "110" are long-range aircraft and have undisclosed electronic navigational and interception aids. One of the main reasons for fitting twin turbo jet units is the tremendous rate of climb which can be sustained from their combined thrust, and it is a unique advantage of turbo-jet installations that they can be so simply and closely combined about the thrust axis. It is of interest to record that a "Meteor" aircraft fitted with wing-mounted "Sapphire" engines maintained an average rate of climb of 12,650ft per minute up to a height of 40,000ft and at one period was climbing at a rate of 17,300ft per minute.

There has so far been no mention of the nature of the armament fitted to the newest combat fighters in this country, but unofficial American sources repeatedly quote their armament as being various arrangements of 30mm cannon.



THE AVRO "SHACKLETON" COASTAL AIRCRAFT

Another of our illustrations shows probably the last piston-engined aircraft that will be ordered by the R.A.F. for operational duties, the Avro "Shackleton." It is equipped with elaborate radar devices for Coastal Command duties as a long-range reconnaissance and anti-submarine aircraft. Powered by four "Griffon" engines, it is armed with six 20mm cannons and also carries depth charges and mines.

Bombers

Two four-jet bombers were first flown during the year and were both described in our account of the Farnborough display. One of these is the "Valiant" made by Vickers Armstrongs, Ltd., with Rolls-Royce "Avon" turbo jets, and is now in quantity production. It is a heavily swept shoulder wing aircraft and has a particularly capacious fuselage. Its engines are closely mounted within the profile of the wing roots. The aircraft is reputed to have a top speed and a range in excess of the "Canberra." The U.S.A. were reported to be interested in the aircraft as a medium jet bomber, and also, because of its reputed slow landing speed, as a naval aircraft.

The Short "S.A.4" has a less radical design; its thin wing, although showing a taper from the leading edge, is not swept, neither are the tailplanes, which are set low with dihedral. The engine mounting is unusual, in so far as its four "Avon" turbo jets are mounted in vertical pairs and share a common nacelle on each wing. One advantage arising from this external arrangement is the fact that the aircraft is not so committed by its design to a particular power plant.

The English Electric "Canberra" twin jet bomber is now known with five different mark numbers is in quantity production in this country and in the U.S.A., where it is powered by "Sapphire" turbo jets made in that country. During the year the bomber "MK2" version made two record east to west crossings of the Atlantic non-stop. It left Aldergrove, Northern Ireland, on February 21st and landed at Gander, Newfoundland, 4 hours 40 minutes later, averaging 450 m.p.h. against prevailing head winds at over 40,000ft. Our illustration shows this machine during a low-level demonstration at the Glen. L. Martin works, Baltimore, where it is under production. During a second crossing on August 31st it averaged 480 m.p.h. over a Great Circle course of 2073 statute miles.

Engines

It was apparent from the engines selected for the bigger part of this country's fighter and bomber strength and certain production prototypes that the centrifugal flow gas turbine has been at least temporarily abandoned in favour of the axial-flow unit. Apart from the "GA5" machine, which has "Sapphire" turbo jets, all aircraft announced last year had the "Avon" engine, both being axial-flow engines. The de Havilland "Ghost" and the Rolls-Royce "Nene" are, however, fitted to the earlier production day and night fighter aircraft. These engines have centrifugal compression and develop about 5000 lb s.t.

Thus, the serious challenge from production problems which arise with axial compressors have been accepted in preference to promoting a fuller investigation of centrifugal compression efficiencies, which are several per cent lower than are the axial. It is not surprising, therefore, that in many cases the machine tools and production techniques associated with the mass production of axial components are covered by security regulations as strict as those pertaining to the whole engine.

Nevertheless, the United States Aircraft Production Board reported in November that the jet production rate was the main bottleneck in its own rearmament schedule due to shortage of machine tools.

The Pratt and Whitney Company in the United States had under production two centrifugal flow engines based on Rolls-Royce designs. Its "Turbo-Wasp" based on the "Nene" engine is the first jet turbine to be awarded an overhaul life of 1000 hours, which is comparable with that of piston engines. These "Turbo-Wasps" are fitted in the Grumman "F9F–2 Panther," several squadrons of which are in operation in Korea. In two years of active flying duty the company report that these "Panthers" have flown more than 150,000 hours without a single case of turbine blade failure. The engine proved extremely durable in the face of major battle damage. Many pilots reported "swallowing" rocks, 3in tree trunks and varied debris from their rocket and cannon fire in the air intakes without serious damage or loss of efficiency to the engine output. The other unit is based on the "Tay" and develops over 6000 lb. s.t.

It was the Rolls-Royce "Nene" and "Derwent" engines which were supplied to the U.S.S.R. in 1947, the total being fifty-five, and, contrary to earlier beliefs, all Russian engines which it has been possible to examine so far are centrifugal flowing and of the "Nene" type. One of the first "MiG15" fighter aircraft to be examined by U.S.A.F. engineers is reported from America to have had a "Nene" type engine with modifications which gave it a high performance without water injection or afterburner equipment. A system for producing added thrust without a conventional afterburner has been reported from the U.S.A. In this system fuel is injected before the turbine, rather than behind it, eliminating the need for flame holders, and ignition source and various fixtures required in an ordinary afterburner. Because of a natural ignition delay, combustion takes place a few inches

Foreign Manufacture, under Licence, of British Gas Turbines and Military Aircraft

Country	Aircraft or engine
Argentina ...	R.R. "Derwent" turbojet (for Argentine fighter)
Australia ...	D.H. "Vampire" fighter E.E. "Canberra" bomber R.R. "Avon" turbojet (fitted to E.E. "Canberra" and "F–86") R.R. "Nene" turbojet (fitted to D.H. "Vampire")
Belgium ...	Gl. "Meteor F.8" fighter (assembly only—airframe built in Holland) R.R. "Derwent" turbojet
Canada ...	R.R. "Avon" turbojet (fitted to Avro "C–102" jet liner and "CF–100" prototypes and Canadian-built "F–86")
France ...	D.H. "Vampire" fighter R.R. "Nene" turbojet (fitted to eight various types of experimental jet aircraft and French-built D.H. "Vampire") R.R. "Tay" (fitted in Dassault "Ouragan" S/S interceptor fighter)
Holland ...	Gl. "Meteor F.8" fighter
Italy	D.H. "Vampire" fighter D.H. "Venom" fighter D.H. "Goblin" turbojet D.H. "Ghost" turbojet
Sweden ...	D.H. "Ghost" turbojet (fitted to "SAAB 29" fighter) D.H. "Goblin" turbojet
Switzerland...	D.H. "Vampire" fighter D.H. "Venom" fighter D.H. "Ghost" turbojet
U.S.A.	E.E. "Canberra B.2" bomber (built by Martin as "B–57A) R.R. "Tay" turbojet (built by Pratt and Whitney as "J–48 Turbo-Wasp" fitted to Grumman "F9F–5 Panther," North American "F–93A Sabre" and Lockheed "F–94C") R.R. "Nene" turbojet (built by Pratt and Whitney as "J–42," fitted to Grumman "F9F–2 Panther") A.S. "Sapphire" turbojet (built by Curtiss-Wright as "J–65," fitted to Republic "F–84F Thunderjet" and "RF–84F") A.S. "Python" turboprop A.S. "Mamba" turboprop A.S. "Double Mamba" turboprop Bristol "Olympus" turbojet

Abbreviations: D.H. = de Havilland, E.E. = English Electric, A.S. = Armstrong Siddeley, R.R. = Rolls-Royce, Gl. = Gloster

aft of the turbine wheel. The turbine nozzles function as atomisers. This method eliminates the weight of an afterburner and does not interfere with the power or efficiency of the jet engine.

There were two power installations shown for the first time at Farnborough and a brief description of them was recorded in our report of that display.

The Napier "Nomad" engine is a compounded diesel engine and turbine developing together 3000 s.h.p. plus 320 lb s.t., each unit driving one-half of a contrarotating propeller. The fuel consumption quoted at that time was 0·36 lb per b.h.p.-hour maximum continuous power. The other installation was the "Snarler" bifuel rocket motor, made by Armstrong Siddeley Motors, Ltd. It is being flight tested in the tail of the Hawker "P.1022" and is intended to augment the climb and manœuvrability of combat aircraft.

On page 55 is a table showing the extent of foreign manufacture under licence of British gas turbines and military aircraft.

(To be continued)

Gas Turbines in 1951

No. I

THE British research and development programme upon gas turbine plant designed to consume indigenous fuels and the progress which was made achieved a special prominence during theyear. Gas turbines able to consume pulverised solid fuels and operating within limits to assure a life of 100,000 hours promise to extend the potential uses of this prime mover far beyond its employment as a source of peak load power for stationary and marine plant, a sphere in which, burning distillate fuels, it is already acceptable. Much work was being done also on plant designed to burn heavy residual oils which, however, in the quantities at present available, is more expensive than coal.

A great variety of gas turbine cycles suited to solid fuels and different combustion processes presented themselves for investigation, and the work organised in this country by the Ministry of Fuel and Power was discussed in the thirty-eighth Thomas Hawksley Lecture,* by H. Roxbee Cox, chief scientific officer to the Ministry of Fuel and Power.

The paper first mentioned the laboratory work on combustion test rigs for open-cycle internal combustion cycles with combustion taking place in one stage and the pulverised fuel particles in suspension. These chambers were of two kinds, the vortex chamber and the straight-through chamber with a "multi-grid" burner. Other work relating to a cyclone slagging chamber was described, in which the combustion is largely effected on the refractory walls of the chamber. With this system most of the ash drained down the walls in a molten state to an overflow, whereas with the former chambers the throughput to the turbine carried the whole of the ash content before cleaning.

Mention was then made of progress with an open cycle two-stage internal-combustion coal consuming set and of a gas producer working in conjunction with the cycle at a pressure of 6 atmospheres. A pilot-scale producer plant was already running. In this plant combustible gas is produced, being the first combustion stage, the gases being then burnt in a main combustion chamber. This meant that cleaning could be confined to the first or gasification stage, which involved only about 10 per cent of the throughput. The paper then went on to describe work on the open and closed cycles, where combustion takes place externally in an air heater so that the gases do not pass through the main turbines. Mention of coal pumps used in conjunction with the open-cycle plant was made.

Other interesting projects described were those where upcast fire-damp was burnt in an open cycle with either auxiliary gas or even a pulverised fuel. The paper then went on to discuss the practicability of underground coal gasification. Elsewhere was described the progress of peat burning equipment. In another part of the paper, which was not included in our abstract, the author referred to the centrifugal progress of compression and reviewed the advantages of each and their limitations. He stated that the present neglect of the centrifugal compressor was unwarranted, and were it to continue might definitely hinder progress. Consequently a contract had been placed for an experimental compressor which will ultimately be incorporated in a coal burning gas turbine. Being a stationary unit, there will be no undue restriction placed upon its size and weight. The compressor has two stages with intercooling; a compression ratio of 5 : 1 with tip speeds at 1100ft per second, a speed which had been shown to be nearest that for optimum efficiency, as against the 1500–1600ft per second of jet propulsion units; an air mass flow of 40 lb per second and a speed of 8250 r.p.m. In view of the experimental nature of this plant, the paper states that very generous diffusers had been fitted which, together with the intercooling, had contributed to its overall diameter of about 9ft for an impeller diameter of only 2ft 6in.

Further reference to the projects mentioned in this paper appear under the heading below of the manufacturers concerned. Some of the combustion chambers mentioned in this lecture are amongst those described in more detail by T. F. Hurley, chief research engineer at the Fuel Research Station in a paper contained in the *Journal of the Institute of Petroleum*, Vol. 37, No. 333, September, 1951.

It first discussed some film cooled metal combustion chambers with special reference to the chamber developed by and for the Bituminous Coal Research, Inc., U.S.A. This chamber has been fitted to an experimental unit with basically similar components to those which will be used in a 4000 h.p. locomotive in that country. Each chamber is designed to burn 2000 lb of coal per hour at a pressure of 4 atmospheres. It was stated that as a result of work carried out in various places the output of a given chamber was found to be roughly proportional to pressure, i.e., without decreasing the efficiency of combustion and without increasing the metal wall temperatures. Thus combustion data obtained at atmospheric pressure can be applied directly to the design of pressurised combustion chambers.

The burner of this unit is a modified form of the "multi-jet" burner designed by T. F. Hurley for use with Lancashire boilers and the theory was described. It enabled a comparatively short flame of the desired shape to be obtained in a small relatively cold combustion chamber.

Some other smaller chambers of this kind were described as was a relatively large unit designed by the Westinghouse Company, U.S.A., where coal is mixed with water to form a slurry fuel charge.

Work at the Fuel Research Station on refractory chambers was next discussed. One combustion rig consisted of a straight-through chamber designed to burn 500 lb coal per hour when at atmospheric pressure with "grid" or "multi-jet" burners, and is externally air cooled. It was found possible to avoid slagging on the walls, but not the deposition of sintered ash at the lower end. This condition might be overcome by making the lower end of the chamber of film cooled metal walls. By maintaining the refractory walls at a high temperature this type of chamber could be used as a slagging chamber. The effect of varying loads and temperature with different fuels on the refractory walls was mentioned.

The author then discussed the principle of the vortex combustion chamber, which was first designed by him in 1929 in order to obtain controlled relative motion to speed up combustion by scrubbing away the stagnant film surrounding the coal particles, the nature of the scrubbing action having been first observed by Dr. C. H. Lander. This kind of chamber was later developed by the Americans to give a very high heat release of 3,000,000 B.Th.U. per cubic foot per hour. The most recent experimental plant at the Fuel Research Station was described; it has a combustion of 500 lb per hour at atmospheric pressure with an efficiency of 90 per cent.

The cyclone combustion chamber which is being developed by the British Coal Utilisation Research Association was then described. Here, again, although controlled relative motion is also sought, the cyclone chamber aims to collect as much ash as possible in the chamber and to remove it as slag, whereas in the vortex chamber the deposition of ash and of slag is as far as possible avoided. In this plant granular fuel (below $\frac{1}{16}$in) is introduced at the top and is centrifuged to the walls which are covered with a film of molten slag. This slag retains the fuel until it has been burnt by the scrubbing action of the air. The walls are described as being water-cooled refractory and are designed to waste away until they reach an equilibrium condition with the inner slag coating. This coating is constantly renewed by more ash as the previously deposited ash fluxes and runs away down the walls to an overflow. The paper describes the present chamber as being about 2½ft in diameter and 10ft high, which has successfully burnt 500 lb fuel per hour with a high combustion efficiency. About 85 per cent of the ash content is collected as slag.

In many cases, both with the work described above and with other gas turbine plant under test or construction, little detailed information is available, as it is still too early to discuss the progress made.

The following information relates to the work in hand in the main companies engaged upon gas turbine manufacture in this country.

Metropolitan-Vickers Electrical Company, Ltd.

Following the successful operation of the Metropolitan-Vickers gas turbine in the naval vessel M.G.B. "2009" (now M.T.B. "5559"), the Admiralty authorised the manufacture of four larger turbines for two M.G.B./M.T.B. "convertibles."

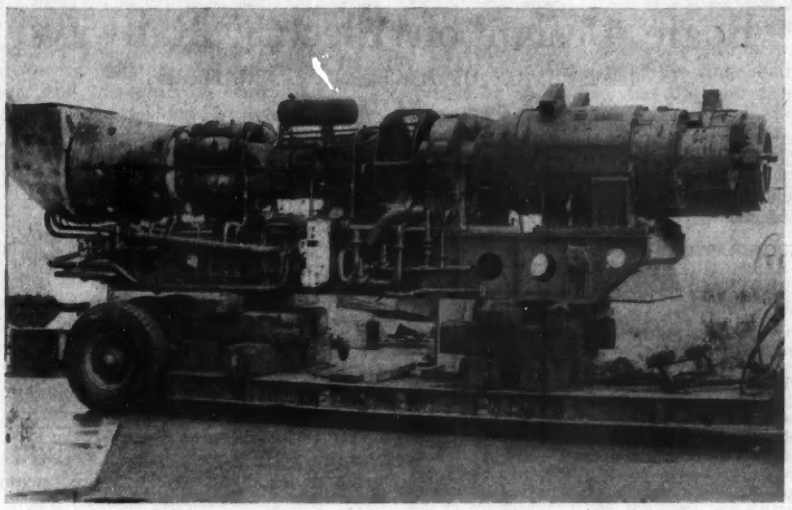
It will be recalled that this company began developing an axial-flow gas turbine with an annular combustion system as early as 1938. Such an engine first flew during 1946 and was later fitted to the Saunders Roe "SR/A1" flying-boat fighter, and was

*The Institution of Mechanical Engineers. "Some Fuel and Power Projects" Nov. 6, 1951.

then known as the "Beryl" turbo-jet. This turbine had a ten-stage axial flow compressor driven by a single-stage turbine. It developed about half the thrust of the "Sapphire" jet turbine, which, though of similar design to the "Beryl" and originally designed by Metropolitan-Vickers, was subsequently developed and manufactured by Armstrong-Siddeley Motors and is at present rated at over 7000 lb static thrust. The gas turbine fitted to the M.G.B. "2009," the first vessel to be thus propelled, was described in THE ENGINEER, September 5, 12 and 19, 1947. This turbine is similarly fitted with an annular combustion system and employs a nine-stage axial compressor driven by a two-stage turbine and has a four-stage "free" power turbine which drives the centre propeller through a double-helical single-reduction gear. This turbine unit develops 2500 s.h.p. The four larger turbines which have now been authorised, three of which are complete, have a maximum design rating of 4800 s.h.p. and are of the same general type as the "Beryl" and the earlier marine units. Each boat will have two gas turbines for boost ahead power and two diesel engines for cruising and manœuvring.

The 2000kW open-cycle set with heat exchanger installed in the company's power station has been undergoing overhaul and modification prior to an extensive programme of testing on heavy oil fuels. Work has now commenced on the site of the 2000kW producer gas burning plant for the Ministry of Fuel and Power. This set works on the open cycle and has a fifteen-stage axial compressor driven by a four-stage fixed shaft turbine. It burns hot gas from a pressurised gas producer working at six atmospheres which is designed jointly by the Incandescent Heat Company, Smethwick, and Joseph Lucas, Ltd., of Burnley. Apart from providing the main set, Metropolitan-Vickers is also supplying the supercharging turbo-compressor in the pressurised producer circuit. The design speed of this unit is 27,500 r.p.m., and the turbine is of radial design working at 650 deg. Cent.

The company states also that the manufacture of the 2500kW set for the Metropolitan Water Board and the 1750kW set for the Shell Petroleum Company has also reached an advanced stage. The former unit works on a simple open cycle burning gas oil, and its design is based on this company's locomotive gas turbine. The 1750kW set is of similar design, but is to use natural gas as its fuel.

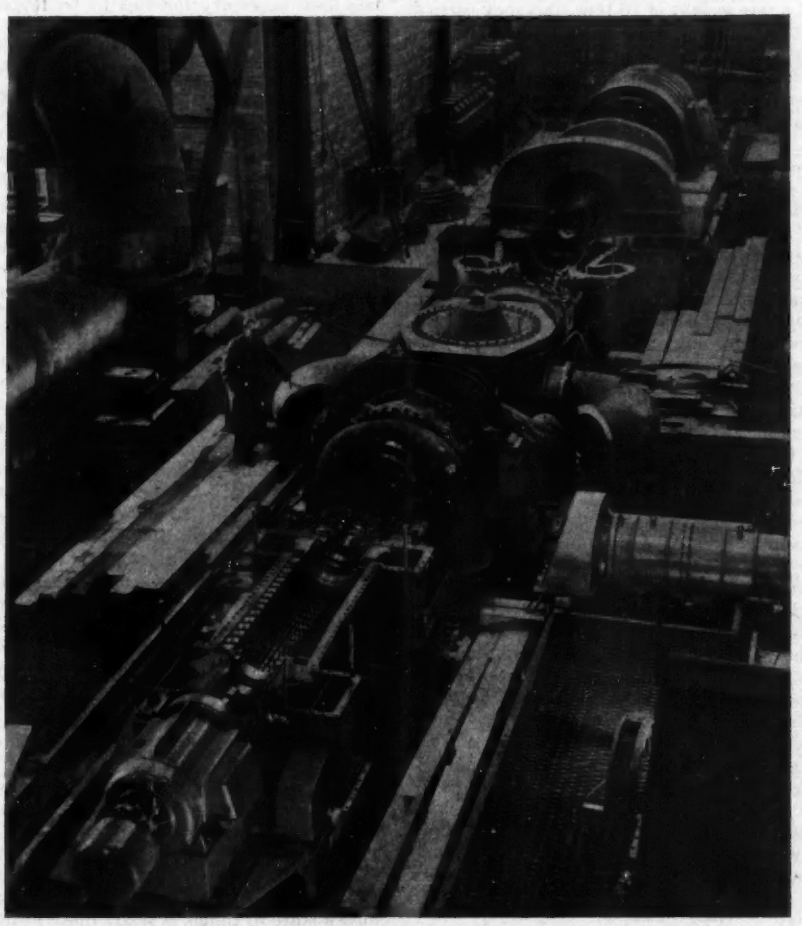


3000 H.P. LOCOMOTIVE SET

Work on the erection of the 15,000kW set at the Trafford generating station of the British Electricity Authority is also well advanced, as can be seen in our illustration, and test running is expected to take place early in 1952. This compound unit employs two axial compressors with intercooling and two turbines, two combustion chambers and a heat exchanger.

The gas turbine unit for the locomotive built by the company for Western Region, British Railways, which has completed satisfactorily extensive bench tests, was installed in the locomotive. The vehicle has been handed over to British Railways and was undergoing running tests preparatory to being put into service.

This gas turbine is a simple open-cycle plant having a five-stage turbine to drive both the axial compressor and the generators. The combustion system consists of six flame tubes and there is no heat exchanger. It is a six-axle locomotive, 66ft 9in long and weighs 120 tons with a nominal rating at the coupling of 3000 h.p., equivalent to about 2450 h.p. at the rail. The gas turbine is shown in one of our illustrations prior to installation on the chassis. Details of this unit are expected to be released shortly.



15,000kW GAS TURBINE GENERATING SET

THE ENGLISH ELECTRIC COMPANY, LTD.

A range of marine and land gas turbine plant is now being run or is under construction at the Rugby works of the English Electric Company, Ltd. Amongst this plant are units of up to 20,000kW, which are the largest being developed in this country.

A unit which this company hopes to run this year is an open-cycle set of 2000kW capacity which is designed to burn coal in a cyclone slagging combustion chamber. The products of combustion with what ash content remains are then cleaned before reaching the two-stage compressor turbine; the free power turbine also has two stages. In the heat exchanger pairs of plates with angular corrugations are mated to form passages for the gases, whilst the pressure air flows contrawise between the pairs. The turbine is fitted with a six-stage axial compressor, which employs a centrifugal impeller for the last stage. Apart from the combustion plant, a similar gas turbine has been ordered by the Ministry of Fuel to burn fire-damp and auxiliary coal. This set is expected to run towards the end of 1952.

(*To be continued*)

Bogie Design on Electric Railways

INSTITUTION OF MECHANICAL ENGINEERS

No. I

AT a general meeting of the Institution of Mechanical Engineers, last Friday, January 4th, the following paper was presented and discussed :—

CONSIDERATIONS ON BOGIE DESIGN, WITH PARTICULAR REFERENCE TO ELECTRIC RAILWAYS.

By W. S. GRAFF-BAKER, B.Sc. (Eng.), M.I.Mech.E.

An examination is made of the dynamic characteristics of wheel sets and bogies, and of the various forces which act upon a bogie under service conditions. The fundamentals of bogie design are considered, and particular mention is made of recent developments in methods of body suspension. Problems of frame construction, braking and power transmission are also considered. The paper concludes with a survey of the development of bogie design on the railways of London Transport Executive and elsewhere, and a restatement of the basic problems in the relationship of bogie to track.

In the unavoidable absence of the author, who was in hospital, the paper was presented by Mr. A. W. Manser.

DISCUSSION

Sir William A. Stanier, F.R.S. (Past-President), said that at the time of his first association with the railways, the rolling stock had had four or six wheels ; but soon afterwards, Dean had introduced the bogie, which was shown in the paper, with the suspension bolts at the corner of the bogie frame, and after that had developed the suspension bolts between the wheels. At the time that bogie had given the best riding vehicles that had ever been known. The figure in the paper did not show the more usual form, which was to have two suspension bolts at each end on the suspension bar, so that the bogie frame had a suspension bolt on each side of it which prevented it from twisting. That bogie was of very light construction, and for stock up to 48ft length certainly gave better riding than anything that existed at present. Unfortunately, traffic conditions had necessitated the building of coaches of 60ft or over, and the angling of the suspension bolts with the longer vehicles made very uncomfortable riding. Ever since that day the railways had been in trouble with regard to bogie design. For the main line the important thing was to prevent the wheels from developing a double flange. Most of those who had been on the railways knew what a double flange wheel was ; carriage wheels, if they got more than one-sixteenth hollow, always led to bad riding. The author referred to the cylindrical wheel. It was appreciated that to make two wheels exactly the same diameter of a cylindrical form was a bit of precision work which one did not usually get in a wheel shop, and it had been found, after making a number of experiments on the Liverpool and Southport line, when a rapid cinematographic camera had been used to photograph the movement of wheels on the rail, that the cylindrical wheel had some disadvantages, in that if the flange got against the rail it stopped there until it struck some points. The solution was to alter the wheel to a 1 in 100 cone instead of the 1 in 20 cone, which was usual. This gave exceedingly good riding. It had not got the same tolerance for wear as the 1 in 20 cone, but it had sufficient tolerance for carriage stock. There was a certain movement on the railways to build lighter stock. He was of the opinion that with lighter stock it would be more and more necessary to reduce the coning of the wheels, because the sinusoidal movement with a 1 in 20 cone could react quite seriously on the carriage body. With a light stock the 1 in 100 cone might be a solution.

Mr. Julian S. Tritton, M.I.Mech.E., remarked upon the author's statement that vertical irregularities of the track must be absorbed by the bogie without being transmitted to the body. Ideally one would go further than that ; surely what one wanted to do in dealing with vertical irregularities (by which was really meant rail joint shocks) was to absorb them where they occurred, i.e., at the point of contact between the tyre and the rail. The only practical method so far evolved for doing that was the pneumatic tyre, with its swallowing action. There was however, no mention in the paper of a compromise—by which he meant the resilient wheel. Many of those present had had an opportunity of riding in what was known as the American P.C.C. car, which was mentioned in the paper. In Washington he had had experience of streetcars fitted with resilient wheels in which the tyre carried a thin inner steel flange on either side of which was mounted a pair of heavy rubber rings. Those rubber rings were bonded to the inner flange, and the tyre was held in position by through bolts and dowels on to the wheel centre, but was completely isolated from it. The effectiveness of the resilient wheel in damping out the rail joint shocks was extraordinary. Of course, it was realised that so far the resilient wheel had severe limitations. The P.C.C. cars had an axle load of 6 tons and a tare weight of 16 tons, but they carried up to sixty seated passengers, and they had very easy springing—so much so that one passenger stepping off the car was sufficient to sway the whole car to an extent that other passengers noticed it. So far the wheels had not been developed beyond that stage, but surely a limitation to a 6-ton axle load could not be contemplated.

Mr. W. A. Agnew, M.I.Mech.E., said that the author's cavalcade of bogies brought to him somewhat of a nostalgic feeling. For some of the types shown he must acknowledge paternity. The problem of bogie design was rendered more difficult on the tube railways by reason of the restrictions imposed by the narrow load-gauge limits and sharp curves met with in the original tunnel sections, coupled with the need to run at much higher speeds on the outlying sections. He felt that the author was pursuing a wise policy in increasing the number of driven axles and thus reducing the hammer blow on the track by lighter motors. An additional advantage was obtained by thus permitting the use of non-metallic brake blocks on such trains and presenting the permanent way engineer with wheels less destructive to his rails. As the author said, the whole question of bogie design was in a state of flux throughout the world. It might not be inappropriate to add that the question of revising the whole railway mechanism was receiving much attention, as some modification of the Stephensonian railway appeared to be inevitable if they were to retain their full share of the country's transport. It was unthinkable that the railways, with their inherent safety of working (due to their guided wheels and signal system) and their immense capacity for national service, should be allowed to decay.

Dr. H. I. Andrews, M.I.Mech.E., referred to the author's plea for consideration of the bogie and the track together and his consequent recommendation of the use of fully suspended motors. The damage which was occasioned to the track by a nose-suspended motor was roughly proportional to the weight of the motor to the square of the speed, and was affected by the length of the wheel base ; so that for the fast running which would be probably required in the future, it appeared that fully suspended motors would be almost inevitable.

Before the war these facts had been considered by the L.M.S. Railway, and a more or less experimental design of bogie for very high-speed running had been produced with fully suspended motors and a very simple form of link mechanism which was included inside the gear wheels. No difficulty had been found in incorporating two 375 h.p. motors, but, of course, it had given a very heavy bogie, giving a total weight of 17 tons. The author seemed to be a little guarded about maintenance and cost, so perhaps the experience with these bogies might be of interest to him. They had now been running for about five years and while, from the nature of their duties, they had not put up any very great mileage over that period, in all other ways they had been very severely tested. Often they had been very considerably overloaded, they had run at speeds up to 85 m.p.h. and they had also been used in very fast-running goods trains, where they were subjected to very considerable shock, so that they had been very thoroughly tested out in that way. Originally there had been one very small defect in erection, and this had been very quickly put right. Later one of the quill nuts had worked loose because apparently the type of fastening which had been used for it was not sufficiently strong, and it had been necessary for this to be replaced. To avoid the difficulty in future, as no one wanted to take the quill nuts off, they had been tack-welded into position, and this appeared to have got over the trouble. Apart from this, none of the other gearcases had been removed at all. Thus, after five years it had been thought desirable to have a look at them. All the gearcases had been taken off and a number of people had inspected them, but as nobody could find anything to do on them, the gearcases had been put back again. He thought that it could be said that the experience so far indicated that the only ordinary maintenance that was needed was simply putting oil in. It was only fair to say that these flexible drives were fitted with roller bearings ; and, just as with axleboxes, if one used the sleeve bearing instead of the roller bearing, one got a much cheaper job, but there was a tendency to greater cost of maintenance. The cost of these drives, both in estimate and in fact, worked out at about 20 per cent of the cost of the corresponding motor. This was certainly an item, but the alternative, which Mr. Agnew had mentioned—the only reasonable alternative to a fully suspended motor—seemed to be to have a very large number of smaller motors spread down the train, which resulted in an increased cost and most certainly resulted in increased maintenance.

Mr. J. L. Koffman remarked that the number of bogies illustrated in the paper conveyed a clear picture of the state of the art. It appeared that there were a very few well-established principles, but apart from these, the question of design was treated as if the whole matter were one of art rather than science. In principle one had to agree with Sir Edmund Whittaker that : "Probably such a state of things is really quite healthy : first get on with the discoveries in any way

possible and let the logic be cleaned up afterwards." However, bogies had been with them for about 100 years, and he felt that the time had arrived when the logic should be cleaned up—and very thoroughly at that—and here the paper was a most valuable contribution in the right direction. The fundamental scientific work carried out on the subject of vehicles running on rails during the past fifteen years, particularly by Heumann and Borgeaud, was of the utmost importance, and he felt that future generations of railway engineers were going to benefit from it to a very considerable extent. The author favoured the use of one motor per bogie. Could he enlarge on the subject, particularly with regard to any evidence which might be available to him to confirm that such a step was desirable, especially so far as riding qualities were concerned? It had been shown by Heumann that with a bogie having unequally loaded axles a damping effect was obtained with the heavier loaded axle running at the rear, whereas if it were running first the bogie would tend to run crab fashion.

Mr. A. F. Cook, A.M.I.Mech.E., referring to the statement in the paper that clearance must be provided between the axlebox and the bogie frame, felt that this statement could be questioned not only in the light of technical evidence, but also in the light of the evidence afforded by the illustrations of some recent Continental bogie designs which appeared in the paper.

Mr. G. C. Jackson said that, having been engaged on lightweight diesel traction since well before the war, he had had more than a fair share of bogie troubles and particularly bogie frame troubles. In the majority of cases these troubles had been with all-welded bogies. He felt that in changing over from riveted bogies to all-welded bogies quite a number of engineers had gone wrong in taking the riveted bogie as a basis for the all-welded type, and that in the early days there had been a lack of appreciation of the sudden changes in section which could occur on a riveted bogie which had been more or less taken as a basis for the welded type. He thought that far less troubles would have occurred if they had taken the cast steel bogie as a basis and fabricated a bogie on those lines. Those two bogies seemed to him to have one essential feature in common, and that was the necessity on either cast steel or all-welded bogies to avoid sudden changes in sections. His company had had some rather costly experiences in the past with that type of bogie, and were now concentrating on all-welded bogies of a box frame construction. They were attempting to take all tractive, braking and spring forces centrally on the centre line of the sole-bars without any overhanging forces. The bogie to which he was referring was supported entirely on coil springs and the damping was carried out by hydraulic shock absorbers which were also mounted centrally in the bogie sole-bar. He asked what were Mr. Manser's opinions on the question of hydraulic shock absorbers for damping both vertical and side movement of the bogie. They appeared to have the right characteristics, particularly for the side movement, because they had a comparatively small resistance to the initial movement, but quite a big resistance to the return movement.

Mr. F. H. Beasant, M.I.Mech.E., noted that the desirability of carrying the whole of the motor weight and, indeed, as much as possible of the gear transmission weight on springs had been stressed by the author, who also emphasised the desirability of reducing the mass of the electric motors in a bogie in order to improve riding characteristics. Both of those desirable features could be achieved by the use of cardan shaft drive motors, with the development of which he had been closely associated in the last few years. By abandoning the spur gear principle and adopting a right-angle drive, not only had the motor been carried on springs and a much sounder form of gear unit been introduced, but the practical limit of gear ratio had been increased from about 6 : 1 to about 8 : 1. This enabled the motor size, weight and cost to be reduced in all cases where the maximum vehicle speed was not required to be more than about 55 m.p.h. Such an arrangement having a motor on each axle admitted the possibility of higher rates of acceleration and of economically providing electric braking, if required.

On the subject of resilient wheels, with which he had been concerned for a number of years, several speakers had asked whether it was possible to build a resilient wheel which would withstand the axle loading associated with the bigger tread. He thought that the answer was that it was quite possible, and whether it was the right thing to adopt or not was purely a question of economics.

Mr. N. Thorneley noted that the author referred to the Dean suspension and indicated that it was to be used on the Metropolitan-Vickers gas turbine locomotive for British Railways. This was very definitely not the case. While the Metropolitan-Vickers gas turbine locomotive naturally had a swing link suspension, the links had no springs at either end and did not directly connect the bogie frame to the body pedestal supports, there being an equaliser beam interposed, which was free to pivot in all directions. Also, all link movement was taken by means of bonded rubber universal joints at each end of the links.

(To be continued)

Generation Plant Construction in 1951

In a statement made at a Press conference on Thursday, January 3rd, Lord Citrine, chairman of the British Electricity Authority, announced that a record amount of generating plant was installed and brought into service in 1951. He said that in spite of many serious difficulties, mainly due to inadequate priorities for the supply of materials, the new plant brought into service during the year gave an additional output capacity of 1113MW. This total was 148MW, or 15·3 per cent, more than in the previous year and 410MW, or 59 per cent, more than in 1949.

The achievement, said Lord Citrine, was remarkable because it was the first occasion in the history of the electricity supply industry of this country that new generating plant giving an aggregate additional output exceeding 1000MW has been installed in a calendar year.

The additional plant, comprising twenty-eight turbo-alternators with an aggregate installed capacity of 1,235,000kW, and forty-six boilers having an aggregate evaporative capacity of 13,080,000 lb per hour, was installed in twenty-five power stations of the Authority. Ten of these are new stations in which plant was brought into service for the first time. A summary of the turbo-alternators, boilers and high-pressure pipework installed in each of the twenty-five stations during 1951 are tabulated herewith.

The Authority has planned for considerably higher rates of commissioning in future years, as the following figures indicate :—

Calendar year	Planned megawatts (sent out)
1950	850 to 1100
1951	1000 to 1250
1952	1150 to 1400
1953	1300 to 1500
1954	1400 to 1600
1955	1500 to 1700
1956 onwards	1600 to 1800

It is worth noting that in the years 1950 and 1951 the plant actually commissioned coincided almost exactly with the mean of the planned bands for these two years.

Plant Commissioned by the British Electricity Authority in 1951

Name of power station	B.E.A. Divisions	Turbo-generator plant: Installed capacity in MW	Turbo-generator plant: Maker	Boiler plant: Capacity in lb/hr	Boiler plant: Maker	Main high-pressure pipework: Maker
Agecroft	N. Western	—	—	2×315,000	International Combustion	Stewarts and Lloyds
Battersea "B"	London	1×60	Metropolitan-Vickers	—	—	Aitons
Blackwall Point*	London	2×30	English Electric	2×365,000	Babcock and Wilcox	Babcock and Wilcox
Brachead*	S. West Scotland	2×50	C. A. Parsons	3×300,000	Babcock and Wilcox	Babcock and Wilcox
Bromborough*	Merseyside and N. Wales	2×50	English Electric	4×300,000	Babcock and Wilcox	Stewarts and Lloyds
Clarence Dock	Merseyside and N. Wales	1×51	Metropolitan-Vickers	—	—	Stewarts and Lloyds
Cliff Quay	Eastern	—	—	2×365,000	Babcock and Wilcox	Aitons
Clyde's Mill	S. West Scotland	1×30	English Electric	2×180,000	Yarrow	Stewarts and Lloyds
Croydon "B"	S. Eastern	2×52	Metropolitan-Vickers	3×320,000	Simon Carves	Aitons
Fulham	London	1×60	English Electric	—	—	Aitons
Keadby*	Headquarters	—	—	1×550,000	Stirling Boiler	C. A. Parsons
Llynfi	S. Wales	2×30	English Electric	1×300,000	Stirling Boiler	Stewarts and Lloyds
Nechells "B"*	Midlands	2×52	C. A. Parsons	3×230,000	International Combustion	Stewarts and Lloyds
Neepsend	Yorkshire	—	—	2×190,000	Mitchell Engineering	Aitons
North Tees "C"*	N. Eastern	1×60	C. A. Parsons	2×360,000	Babcock and Wilcox	Babcock and Wilcox
Peterborough	Eastern	2×20	English Electric	3×160,000	Babcock and Wilcox	Babcock and Wilcox
Plymouth "B"*	S. Western	1×31	Metropolitan-Vickers	1×320,000	Yarrow	Babcock and Wilcox
Poole	Southern	1×50	Metropolitan-Vickers	3×300,000	International Combustion	Aitons
		1×50	C. A. Parsons			
Portobello	S. East Scotland	1×60	Richardsons Westgarth	—	—	Aitons
Rye House*	Eastern	1×32	Richardsons Westgarth	1×350,000	Babcock and Wilcox	Stewarts and Lloyds
Skelton Grange*	Yorkshire	2×60	C. A. Parsons	3×360,000	International Combustion	Aitons
Staythorpe	E. Midlands	—	—	2×240,000	Babcock and Wilcox	Aitons
Thornhill	Yorkshire	—	—	3×180,000	Mitchell Engineering	Stewarts and Lloyds
Walsall	Midlands	—	—	1×180,000	Babcock and Wilcox	Aitons
Westwood (Wigan)*	N. Western	2×30	British Thomson-Houston	2×300,000	Babcock and Wilcox	Stewarts and Lloyds

* New stations in which plant has been commissioned for the first time in 1951.

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B.E.A. POWER STATION PROGRESS

THE recent announcement by the British Electricity Authority that the amount of new generating plant taken into service in 1951 gave an increased output capacity of 1113MW, —an increase 15·3 per cent greater than that of 1950—gives ground for sober satisfaction. Six months ago the prospect seemed bleak when Lord Citrine stated that the constructional programme was falling seriously behind schedule, mainly because the supply of raw materials was not receiving adequate priority. Indeed, the generating plant commissioned in the first ten months of the year totalled no more than 507MW, although a much greater quantity was being pressed forward to be in service for the winter load. As it turned out, the immediate difficulties were overcome to such an extent that by the end of the year twenty-eight turbo-alternators, totalling 1235MW, were installed, together with forty-six boilers having an aggregate capacity of 13,080,000 lb of steam per hour.

These figures, and the details which we reproduce on page 59 of this issue, reflect a substantial joint achievement by the manufacturers and the electricity supply industry, and they offer hope that, provided the necessary supplies of labour and materials are made available, future generating plant programmes are capable of achievement in full. One encouraging sign is that in 1950 (for the first time in the recent history of the supply industry), and again in 1951, the total plant capacity of the planned programmes was actually commissioned. It is evident that the manufacturers, for their part, are in a much better position than they were a few years ago, to meet the British Electricity Authority's demands for plant, now that the additional manufacturing facilities laid down after the war are coming into service. The task is certainly made easier by the steady trend towards standardisation, in the interests of productivity, first with turbo-alternator sizes and steam conditions, and then with boilers, steam piping, auxiliaries and station lay-out generally. On the other hand, the perpetual tug-of-war between technical development and standardisation imposes a need for repeated revision. For instance, there is good evidence to suggest that the most economical size of steam-driven set for the grid is likely to be 100MW instead of the present "standards" of 30MW and 60MW. In other directions the speed of building and commissioning power stations might be accelerated by applying some of the intensive methods adopted by the Americans in plant erection work on site. But the gains would be nullified if shortages of vital components held up any of the multitudinous activities that must be closely co-ordinated in order that delays in commissioning may be avoided.

When all is said, however, the Authority's constructional programmes—which rise gradually from 1150–1400MW in 1952 to 1600–1800MW in 1956—will, even if they are fully realised, leave a considerable gap between the available output and the potential winter peak demand. This gap, which has been increasing yearly since the war, stood at approximately 3000MW in 1951, and the task of closing it becomes more urgent as the rearmament programme gathers momentum. Probably the most useful step that could be taken to reduce the deficit in the present circumstances would be to encourage private generation, particularly by industrial firms who use heat for process work, and could therefore make good use of generating sets driven by pass-out turbines, with much higher overall thermal efficiencies than can be achieved with condensing sets. The economy in the use of coal and the relief of load on the public supply system provide ample incentive for giving close and sympathetic consideration to this method of generation. Indeed, if the demand for coal is to be kept within the capacity of the coal industry to produce, it might even be worth accepting some curtailment of production for the B.E.A. in order to obtain plant that can more fully use the heat available in the coal. That is a point that the Power and Fuel Resources Committee no doubt has under consideration. Not the shortage of generating capacity, but the growing shortage of fuel may, in fact, eventually enforce modification of the pre-war policy of confining the generation of power mainly to central stations, where, as power, it can most efficiently be generated, but where the heat value of the fuel is far from completely utilised. Another method of augmenting the output capacity of the public supply system that merits serious study is the proposition that electricity generated in Norway, for example, should be transmitted by submarine cable to Great Britain. Such a scheme may be feasible technically—at least one cable-making company claims that it is—but it would only be justifiable if it made a substantial and economic contribution to the firm kilowatt capacity of this country. Some strategic considerations are also involved. For more immediate results it is perhaps better to concentrate attention on our home resources. Here, in the last resort, it is the Government that holds the key to the situation, controlling, as it does, capital investment and supplies of raw materials, particularly steel, to say nothing of the primary industries that provide coal, gas and electricity. As far as electricity is concerned, whether publicly or privately generated, it is difficult to see how the rearmament programme is to get into its stride unless capital expenditure is maintained, if not increased. For the B.E.A., in particular, this condition applies equally to transmission and distribution facilities; indeed the 275kV grid, which was originally estimated to cost £52 million spread over six years, must be regarded as an integral part of the public supply system. Further, the whole B.E.A. expansion programme rests on the assumption that the necessary coal supplies will be made available by the National Coal Board. It is a commitment that cannot be taken for granted, involving, as it does, an estimated consumption of 30 million tons annually within the present decade!

STEEL SUPPLIES

ACCORDING to records kept by the United Nations Economic Commission for Europe, the United Kingdom was the only European country whose steel output declined last year. As noted, however, in our annual review last week, that result was in no way a reflection upon the efficiency of the British iron and steel industry. In the four preceding years, its output was in excess of estimates and in 1950 it achieved a record production of 16,300,000 tons. Last year, with the progressive improvement and expansion of production capacity, there is no doubt that a steel output of 16,750,000 tons could have been reached had sufficient raw materials been available. But the sharp fall in supplies of imported scrap—mainly from Germany—and the reduced imports during the first half of last year of rich ores, prevented the iron and steel industry from fulfilling its hopes for 1951. In fact, in order to secure an output of rather less than 16,000,000 tons, it was necessary to draw upon stocks of ore and scrap—a step which obviously cannot be adopted as a regular practice!

The reduced steel output last year, however, has inevitably had disturbing repercussions upon the engineering and allied

industries and, therefore, upon this country's economy. For with rising industrial production there has naturally been a rising demand for steel of all descriptions. It has been suggested that about 150,000 firms in the United Kingdom require steel in order to carry on their businesses, although admittedly a fair proportion of that total consists of comparatively small users. Nevertheless, in 1950, about 10,500,000 tons of finished steel were consumed by home industry, and the total supplies available were in the neighbourhood of 12,500,000 tons. But the growing emphasis on armament production—always a disproportionately heavy user of steel—made it evident early last year that home market needs for finished steel would rise rapidly, and, as the year advanced, steel supplies became increasingly difficult. With the exception of sheet, tinplate, terneplate and blackplate, control over the distribution of steel had been discontinued in May, 1950, but in view of the deteriorating supply situation and the increasing demand, it was decided by the Government that rationing of all descriptions of steel must be reimposed as from February 4th next. The arrangements for distribution control are very similar to those which prevailed from the beginning of the war up to May, 1950, and allocations to steel users have now been made for two months, February and March, of the first quarter of this year, with provisional allocations for the second and third quarters. These allocations have been described as "real" allocations—meaning, we suppose, that users can feel confident there will be no shortfall. But to the majority of users they have proved profoundly disappointing. With steel deliveries tailing off during the latter part of last year and with no opportunity to replenish reduced stocks, it is understandable that the engineering and allied industries find themselves at a loss to know just how they can fulfil their commitments in the coming months. No doubt it was the desire to clarify the position which led the Government to issue, last week-end, the statement reported in one of our "Seven-Day Journal" notes. That statement—which, in the absence of detailed figures, is somewhat obscure in places—emphasised the increasing requirements of steel for defence purposes, and also pointed out that "in face of a trade deficit of unparalleled gravity it is now apparent that the best prospect of achieving an increase in exports is to produce for overseas sale larger quantities of plant, machinery and steel goods of all kinds." The statement went on to explain that as these growing needs must be met, the home market must suffer, but an assurance was also given that the minimum needs of basic industries such as coal, transport and power production would be protected, so that "the sacrifice must be borne by other steel-using industries, in proportions that vary with their importance to the national economy." According to the statement, the national steel shortage has been estimated at 1,500,000 tons. A reduction of that amount must therefore be made in the projected steel consumption of those who produce goods which do not fall within the categories of defence requirements, exports, or the needs of the basic industries.

In wartime, such a situation is readily acceptable, for then, to all intents and purposes, the Government is the only important buyer of steel products. But the necessity to make allocations in peace time really means that the Government decides not only how much steel consumers are to be allowed to have, but also what "priority" is to be given to various products for the home market. In short, the individual citizen no longer chooses what to buy; the Government chooses for him! Obviously, the Government's is a task which it is difficult to carry out at all satisfactorily. Moreover, there are undoubtedly many steel products—hand tools and the like, for example—sold in the home market which are essential to the production of armaments and of goods manufactured for export. Again, if steel allocations to shipbuilders are reduced and shipbuilders are thereby compelled to lengthen delivery dates to their customers, the delivery of ships to home owners who may quite likely require them for the carriage of exports, will be delayed. Assessment of the right allocation of steel for any particular purpose is clearly far from easy! In addition, the control of distribution can lead to reductions of outputs in the steelworks as well as in the works of steel users. In the rolling mills, for instance, it is always desirable to have long runs on a particular section, but under a system of "priorities"—however essential it may be—frequent changes of rolls may have to be made. Nobody, therefore, wants rationing. But, for the present, industry must bear the inconvenience and dislocation caused by the gap between supplies and requirements, even though not a few steel users will find it hard to maintain the production of those goods for which their businesses have been established and organised. They, without doubt, will welcome the Government's assurance that "as soon as more steel is available, allocations will be increased." The shortage of steel-making materials is not world-wide, but it is one of those shortages which are being felt particularly acutely in this country owing to the economic difficulties which are upon us at a time when a big armament programme must be carried through. To raise steel output is the only way to relieve the anxiety which besets British manufacturers at the beginning of this New Year. But the steel industry alone, whose production capacity must now be about equal to current demands, cannot extend its output unless ore, scrap and semi-finished material are forthcoming in greater quantities. Strenuous efforts to obtain these essentials, and to obtain bigger imports of finished steel, are being made. It can only be hoped that those efforts will meet with speedy success.

Obituary

G. A. JUHLIN

As briefly recorded in our last issue, the death occurred at Goostrey, Cheshire, on December 31st, of Mr. G. A. Juhlin, formerly director and chief electrical engineer of the Metropolitan-Vickers Electrical Company, Ltd. He was seventy-one.

Gustaf Adolph Juhlin was born and educated in Sweden. In 1902 he joined the firm of Dick Kerr and Co., Ltd., of Preston, and for many years held the position of chief alternating current design engineer with that firm. In 1915 he joined Metropolitan-Vickers (then the British Westinghouse Electric and Manufacturing Company), and two years later was appointed chief engineer of the plant department, in which capacity he was responsible for the design of all the firm's large electrical machines. In 1941, Mr. Juhlin became chief electrical engineer of the company, and was subsequently elected to the board. He retired in 1947.

Mr. Juhlin had an international reputation as a designer of large electric generators and motors, and contributed many valuable papers to learned societies. He was responsible for a large number of technical developments which, in their time, marked important advances in design. Developments in which he took a leading part were the use of compressed mica insulation for machine windings, the development of rotary converters for d.c. traction service, the application of electric drives to rolling mills, and the development of the modern turbo-generator, including 33kV stator windings. One landmark, outside his usual field, was the introduction in 1928 of the cross-jet explosion pot for high voltage circuit breakers.

Mr. Juhlin was a full member of the Institution of Electrical Engineers and was chairman of the North-Western Centre of the Institution in 1923–24. His wide culture and unbounded energy won him the esteem of a large circle of friends.

Literature

Quartz Vibrators. By P. VIGOUREUX and C. F. BOOTH. His Majesty's Stationery Office, London. 30s.

THIS book is a revised and considerably extended version of the book entitled *Quartz Oscillators and Resonators*, by Dr. Vigoureux, the second edition of which was published in 1939. Since then there has been a vast increase in the use of piezo-electric quartz, particularly in Service equipment during the last war. Although other piezo-electric materials are now receiving increased attention it is true to say that the quartz oscillator is still of primary importance in the communications field. Thus the publication of this book under the ægis of the Radio Research Board is especially welcome. A valuable inclusion is the detailed accounts of the manufacturing techniques and performance of quartz vibrators.

There are in all twenty-four chapters together with a number of appendices and a Bibliography, the emphasis throughout being on the practical developments and processes and on experimental techniques. Following a short introduction, Chapters 2, 3, 4 and 5 deal, in turn, with the properties of quartz, its occurrence and examination, the piezo-electric phenomena in quartz and the theory of the quartz resonator, respectively. In Chapter 4 an elegant method is described for calculating from energy considerations the effect of an air gap on the response frequency. The piezo-electric behaviour is treated phenomenologically and no attempt is made to go deeper into the subject. The valve-maintained quartz oscillator is examined in Chapter 6, whilst the various types of vibrator are discussed in the seventh chapter.

There follows a number of short chapters describing the mounting of the vibrator, the specifications and testing of quartz elements, the ageing problem and means of temperature control. Chapters 12, 13 and 14 are important ones and are given respectively to considerations of frequency standardisation, frequency control of radio transmitters and carrier generation for multi-channel systems. Two brief chapters

on luminous resonators and the nature of the vibrations lead on to Chapter 17, which contains information on frequency selection and filter applications. The authors' treatment of ultrasonics in Chapter 18 is somewhat restricted, presumably in view of Dr. Vigoureux's recent book on this subject. Some miscellaneous applications are described in the next chapter, and the remaining chapters are concerned with production techniques, and future trends.

There is little with which one could find fault in the presentation of this book; it is well written and admirably illustrated. Although it contains much which is not required by the average reader, a sufficiently broad view of the problems is given and the specialist will in general readily find here the detailed treatment which he requires. The book will be regarded as a reference text by those engaged in the manufacture and processing of quartz and all those who employ quartz crystal units in any application. Together with previous works of a more theoretical nature by Mason and Cady, the present text fills the need for a practical reference work.

Letters to the Editor

(We do not hold ourselves responsible for the opinions of our correspondents)

IRON AND STEEL INSTITUTE DISCUSSION

SIR,—

In pages of THE ENGINEER
Its readers wager will appear
A faithful and a true report
Of things and happenings they ought
to know about.

Its usual high efficiency
Last week showed a deficiency,
For its record of the meeting
Of I.S.I. was so fleeting,
some was left out.

The opening contribution for
Doc Finneston and Fearnehough
Does not even get a mention;
Accident or base intention,
How is it so?

Thus, from your pages has been lost
The contribution valued most;
But to the matter which I mention
I would draw your kind attention.
Because I gave it.

H. ALLSOP,
Chief Metallurgist,
Brown Bayley Steels, Ltd.

December 28, 1951.

[In pages of THE ENGINEER
Its readers KNOW there will appear
A faithful and a true report
Of things and happenings they ought
to know about

Its usual high efficiency
Last week showed NO deficiency,
Because its record of the meeting
Of I.S.I. was so fleeting,
some was left out.

The opening contributions, true,
Did suffer from the pencil, blue.
We scorn the use of an invention;
The words were left out by intention!
And with much more.

Were everyone's remarks included,
Printing ne'er would be concluded;
That ENGINEER you value most
Would never, timely, get to post.
We send it!

Native politeness makes us add
Our blue pencil finds it sad,
Thus removing words from place
Merely on the grounds of "space."
Apologies are due!

Ed. THE E.]

Electrical Engineering in 1951

No. II—*(Continued from page 27, January 4th)*

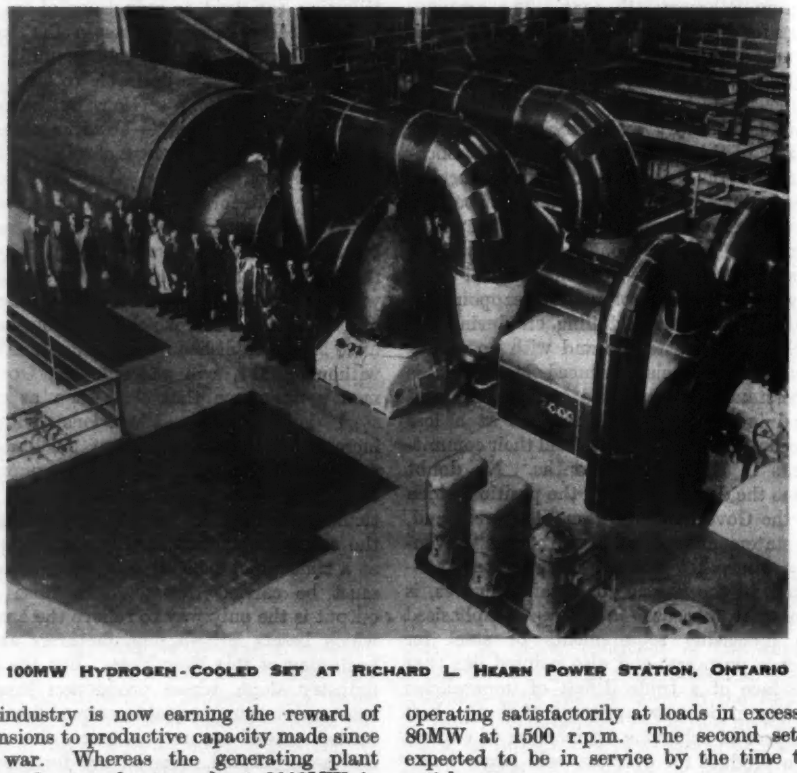
AT a Press conference last week Lord Citrine announced that more generating plant had been commissioned in B.E.A. power stations in 1951 than in any previous calendar year. He stated that additional plant comprising twenty-eight turbo-alternators with an aggregate installed capacity of 1235MW and forty-six boilers with a gross evaporative capacity of 13,080k-lb per hour were installed in twenty-five B.E.A. power stations. The new plant brought into service during the year increased the output capacity by 1113MW, or 15·3 per cent more than in 1950. These results represent a remarkable achievement, particularly in view of the disappointing progress made in the first ten months of the year when the new plant commissioned totalled only 507MW.

On the manufacturing side it is clear from the annual report of the British Electrical and Allied Manufacturers' Association that the industry is now earning the reward of extensions to productive capacity made since the war. Whereas the generating plant delivered ex-works was about 1100MW in 1948, it was nearly 2000MW in 1949. In 1950 the corresponding total was 2400MW, of which about 1600MW was for the B.E.A., while the bulk of the remaining 800MW was exported. Although the figures for 1951 are not yet available, it is fair to assume that, for every 100MW of plant delivered to the B.E.A. something in the region of 40–50MW of plant was exported; a few details of some of the more important export contracts may therefore be of interest.

An interesting overseas project that came to fruition in 1951 was the commissioning of the first 100MW 1500/1800 r.p.m. hydrogen-cooled turbo-alternator at the Richard L. Hearn generating station of the Ontario Hydro-Electric Power Commission, as illustrated herewith. The unit was ordered from C. A. Parsons, Ltd., and it was officially started up on October 26th. The main novelty about this set is that it is designed to generate initially at 25 c/s, when run at 1500 r.p.m. Eventually, however, it will be required to generate at 60 c/s, running at 1800 r.p.m. The change from 25 to 60 c/s will be effected by simply changing the generator rotor, two or three weeks being required for the work of conversion.

Three more Parsons sets of the same output are on order for this power station. The second and fourth sets will be straight 60 c/s, 1800 r.p.m. machines, while the third, like the first, will be a dual-frequency unit. Each set comprises a two-cylinder turbine, operating with steam at 850 lb per square inch gauge pressure, a total temperature of 900 deg. Fah., exhausting at a vacuum of 28·5in and driving a single alternator and exciter.

At its commissioning in October the first set was operated for a short period, with air cooling, after which the alternator was filled with hydrogen and thereafter it has been operating satisfactorily at loads in excess of 80MW at 1500 r.p.m. The second set is expected to be in service by the time this article appears.



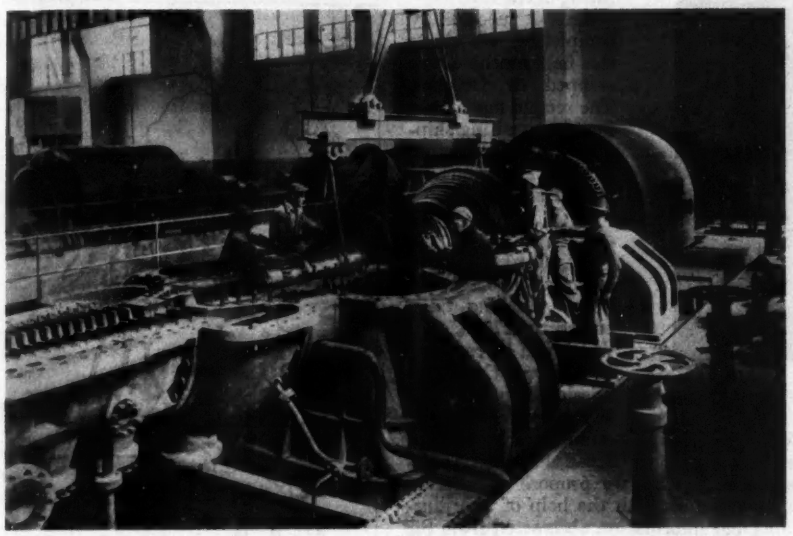
100MW HYDROGEN-COOLED SET AT RICHARD L. HEARN POWER STATION, ONTARIO

Because of transport limitations the alternator stator was manufactured in two parts; the outer casing complete with gas coolers was shipped as one unit, while the inner casing containing the stator core and windings was shipped separately.

Another interesting overseas installation in which a British manufacturer is playing a leading part is the J. Clark Keith generating station at Windsor, Ontario. Like the Richard L. Hearn station, it is owned and operated by the Hydro-Electric Power Commission of Ontario. The power station at Windsor, Ontario, was formally opened on November 16th, when the first of four 60/66MW English Electric hydrogen-cooled turbo-alternators was commissioned. When it is completed in 1953 Windsor power station will be the second largest thermal installation in Canada, and its main function will be to supplement the Commission's

hydro-electric system when water shortage reduces the output or when the peak demand exceeds the capacity of the hydro-electric stations.

Each turbine is a two-cylinder unit of the English Electric Company's usual design, with an impulse high-pressure cylinder and a double-flow reaction, low-pressure cylinder. Normal steam conditions are 850 lb per square inch and 900 deg. Fah. exhausting to a vacuum of 28½in Hg. at 60MW load, the speed being 3600 r.p.m., corresponding to 60 c/s. To achieve close control during starting up and shutting down, the set is equipped with supervisory and protective gear; the instruments include an electrical indicator (besides the usual mechanical tachometer) to indicate and record the speed from about 100 r.p.m. upwards; a shaft eccentricity indicator and recorder; and an indicator and recorder for axial differential expansion. There is also an instrument to indicate high-pressure pedestal expansion, and vibration indicators in the form of pick-up heads are mounted on the bearing pedestals, just below the centre line of the turbine shaft, to measure transverse vibration amplitude.



30MW SET UNDER ERECTION AT PRETORIA "B" POWER STATION

The hydrogen-cooled alternator generates at 13·8kV, three-phase, 60 c/s, the rated output being 60MW at 0·85 power factor, with a "capability" rating of 66MW. The stator core is built up from segmental stampings carried by flexible leaf springs in a skeleton frame within the main stator frame. This construction largely isolates the main structure and foundations from the transmission of 100 c/s vibration produced by magnetic attraction between the rotor poles and the stator core; at the same time, the core is rigidly restrained against the load and short-circuit torques.

To make the alternator a self-contained unit the two hydrogen gas coolers are mounted axially in the upper part of the outer frame. An axial-flow fan with aerofoil section blades is mounted at each end of the rotor to provide gas circulation. This form of construction eliminates all external ducting and simplifies the task of maintaining a gas-tight enclosure.

Excitation is provided by an exciter running at 1000 r.p.m. and driven through gearing from the main alternator shaft.

Another item of generating plant sent overseas during the year was the 30MW English Electric set which is shown, in one of our illustrations, during erection at Pretoria "B" power station.

Reports of technical progress by the manufacturers make some reference to the design of machines for high-pressure, high-temperature steam conditions. From the English Electric Company, for example, we learn that work is well advanced on the manufacture of the first turbines designed to operate at 1500 lb per square inch and 1050 deg. Fah. The machines are three-cylinder, impulse-reaction units,* with high-pressure casing and rotor of simple construction, so as to minimise distortion in those parts of the turbine where temperature differentials are a maximum.

By using internal nozzle boxes the effect of the maximum temperature and pressure is confined to these parts so that the main body of the high-pressure casing is subject only to the steam conditions in the wheel chamber after expansion through the first-stage nozzles. The material used for the high-pressure casing and steam chest is a ferritic steel and, in the event of austenitic piping being used, special transition pieces are necessary between the turbine casing and steam chests and the piping. At present these transition pieces are being imported from the United States, but work has been proceeding in co-operation with the steel makers in this country on the development of alternative transition pieces.

The same company reports that designs are completed and work is already starting on a turbine for 100MW.

Of the English Electric machines completed and in operation, the 60MW, 1250 lb per square inch gauge, 950 deg. Fah. unit, with hydrogen-cooled alternator, in the Stourport "B" power station, has been showing excellent results and overall efficiencies of up to 29·75 per cent have been achieved over long periods.

The British Thomson-Houston Company, Ltd., refers to development work carried out during 1951 on both turbines and alternators. On the alternator side this work consisted chiefly of improvements in hydrogen-cooled alternator design, exciter enclosures, slip-ring ventilation, rotor windings and dielectrics. Several of the large B.T.H. alternators commissioned during the year embodied exciters fitted with Pollock commutators.

*Illustrated in Fig. 16 of Mr. V. A. Pask's paper, "Mechanical Plant for Electricity Power Stations," Joint Engineering Conference, London, 1951.

On the turbine side, developments took place in connection with a new design for 60MW, 3000 r.p.m. machines and the latest arrangement for this rating provides for top and bottom steam admission to the h.p. cylinder. This lay-out gives a more uniform heating of the casing at starting and also, to a large extent, simplifies the production of castings. Associated with this development is the arrangement of an under-floor stop valve, which will considerably improve the appearance of the front end of the machine and will facilitate dismantling of the top half casing for inspection purposes.

Further designs were produced for even larger machines, and it is interesting to note that by increasing the blade length in the l.p. cylinder to give the necessary flow area, a two-cylinder, two-flow design has been achieved which will show many advantages over the previous three-flow design for the same rating. Considerable research was done to obtain reliable data regarding rotor and cylinder expansions and loading rates, observations being made on various machines in service under actual loading conditions. From the results of these tests it has been found that running-up and loading times on machines can be considerably reduced with advantage to the user and to the safety of the machine.

Hydro-Electric Machines

Hydro-electric developments generally are dealt with in our review of Civil Engineering in 1951, and in the present article we shall merely refer to some of the more important items of generating plant commissioned during the year.

At home the North of Scotland Hydro-Electric Board took into service the fourth 35MW English Electric set at Loch Sloy, operating under a gross head of 910ft, and two 22MW sets by the same maker, at Fasnakyle. Another installation that was fully commissioned by the Board was the 35,000 h.p. Grudie Bridge power station of the Loch Fannich scheme, the electrical generating plant being supplied by Bruce Peebles and Co., Ltd., Edinburgh; a description of the plant appeared in our issue of August 10, 1951, page 191. The year was characterised by renewed interest in the use of induction generators on Scottish hydro-electric schemes, and Bruce Peebles plant was installed or completed for Clunie, Pitlochry and Errochty dams. The same company received an order for a 2400kW induction generator (which is believed to be the largest of its kind in the country) for installation at the foot of an 86ft shaft at the Loch Mullardoch end of the 3½-mile tunnel which discharges into Loch Benevean, the main reservoir for the Fasnakyle power station. The alternator will be a horizontal shaft machine, geared and flexibly coupled to a vertical Francis turbine.

A major portion of British manufacturers' activities in the hydro-electric field was concerned with developments overseas. Joint contracts placed with the English Electric Export and Trading Company and the Metropolitan-Vickers Electrical Export Company resulted in the commissioning of two 45MW sets at Castelo do Bode, in Portugal.

June, 1951, marked the starting up of the low-head Tekapo installation in New Zealand. Here a 25MW English Electric generator was commissioned, driven by a 35,000 h.p. Kaplan turbine operating under a 105ft head. It is interesting to learn that the same kind of turbine has been selected for the Invergarry plant in the North of Scotland, where it will develop 28,000 h.p. under a head of 188ft, which is thought to be the highest head

yet contemplated for a feathering propeller turbine.

Among the plant sent overseas during 1951 was the first of three 62·4MVA vertical waterwheel B.T.H. alternators for the Los Peares station of Fuerzas Electricas del Noroeste S.A., Spain. An unusual opportunity for examining the constructional

62MVA WATERWHEEL ALTERNATOR FOR LOS PEARES

details of this machine presented itself in June when delegates to the Joint Engineering Conference visited the B.T.H. works, Rugby, and were able to see various stages in the manufacture of the three alternators involved in the contract; the first machine (illustrated herewith) was completely assembled and running on test, the second machine was in a partially assembled state, and individual details for the third machine could be seen during manufacture.

To meet shipping requirements the stator is designed to be split into four sections. The stator embodies a Roebel bar winding in which every strand of every effective conductor has been transposed into all possible positions within the cross section of the coil side, in passing from one end of the slot to the other.

An important detail from the point of view of maintenance is that the rotor poles can, if required, be removed without lifting the rotor out of the stator. To allow this to be done the coils are supported, to prevent bulging, by steel strips anchored to the pole body (as shown in one of our illustrations) instead of by the usual pole-to-pole vee blocks. The rotor coils are of fabricated construction with jig-saw joints. This arrangement enables hard-drawn copper strip of any desired dimensions to be used, and overcomes the limitations existing with wound coils, in which soft-drawn copper of restricted width/thickness ratio only can be handled by the winding machine. It is also possible to insert wider strips at intervals in the coil height, thus giving projecting fins which assist cooling and increase the permissible rating of the coil.

After successfully completing its tests the first machine was shipped in October. The second machine is in store awaiting shipment, and completion of the third machine is well advanced.

The 275kV Grid

In his I.E.E. presidential address, Sir John Hacking discussed the 275kV grid, which will be required to reinforce the transmission capacity between various parts of the country, keeping in step with the growing generation capacity. Because of the importance of the scheme we propose to refer to it in some detail, with the help of two illustrations and information abstracted from Sir John's address.

The map outlines the 275kV grid which has been designed to meet requirements up to 1960. Briefly, the system consists of a central ring covering the East Midlands, the Midlands, Lancashire and the West Riding of Yorkshire, with a connection to Scotland via the North-East Coast and Carlisle and two direct connections to the London area. These two connections link up, as shown, with an open ring round London, terminating at Tilbury on the north bank of the Thames and Littlebrook on the south. A third link between the Midlands and London is provided by a line via the Severn Valley.

In all, the scheme involves about 1100 miles of new transmission line, the estimated cost, based on 1950 prices, being about £52 million. It is worth noting, however, that the alternative to the 275kV grid scheme would have been ultimately to abandon national operation and to revert to the original conception of the 132kV grid—a number of areas operating independently. However, it was estimated that, to provide the same degree of security of supply under such conditions would have required at least 5 per cent more generating plant and the capital cost would have been greater than that of the 275kV grid.

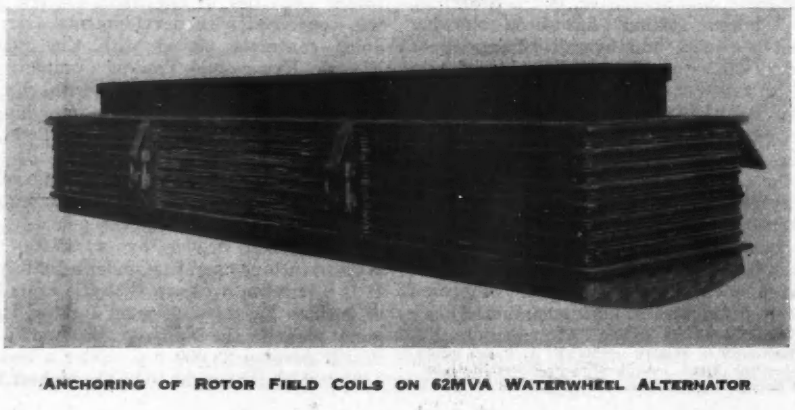
Like the existing grid, the new system will operate with solidly earthed neutral at each transforming point. All the equipment will be designed for continuous operation initially at voltages up to 300kV and an impulse test level of 1050kV.

An experimental 40-mile section of line between Staythorpe and Sheffield is now nearing completion. This comprises single-circuit towers equipped with twin conductors

OUTLINE OF 275KV GRID SCHEME FOR 1960

of steel-cored aluminium on each phase, each conductor being of 0·175 square inch equivalent copper section. For the remainder of the scheme, double-circuit construction will be used, partly on account of the inherent economy in capital cost per kilovolt-ampere of transmission capacity and partly to make the best use of wayleaves. Experience with the existing 132kV system has proved the validity of both these reasons.

Two sizes of conductor will be used—twin 0·175 square inch per phase, having a thermal rating of about 375MVA per circuit, and twin 0·4 square inch per phase, having a thermal rating of about 570MVA per circuit, i.e., 1140MVA gross capacity per line of towers. Comparison of these figures with the 90MVA rating of the original 132kV single-circuit grid lines reflects the development in thought and practice in the field of electrical transmission over the past twenty years. The smaller conductor will provide sufficient capacity for interconnection purposes only, and will be used for the connection from Yorkshire to Scotland. For the remainder of the scheme the larger conductor will be used, and the circuits proposed will provide for a total export of nearly 3000MW from Yorkshire, the East Midlands and Midlands to Lancashire, Merseyside, London



ANCHORING OF ROTOR FIELD COILS ON 62MVA WATERWHEEL ALTERNATOR

and the Southern Counties; of the total export capacity about half will be available for planned exports, the other half being required for interconnection purposes, i.e., for the pooling of spare plant in the exporting and importing zones.

Two ranges of tower design will be used, one for the twin 0·175 square inch conductors and the other for the twin 0·4 square inch conductors. The normal spans will be 1000ft and 1200ft respectively. Both designs will follow the same general outline as the existing 132kV towers and will carry a single earth wire. The accompanying diagram shows the two different types of 275kV double-circuit tower and, for comparison, a standard 132kV double-circuit tower. An important aspect of the new tower design is the use of high-tensile steel. By using 60 per cent of such steel the total weight of the smaller double-circuit tower will be about the same as that of the single-circuit tower which is employed on the Staythorpe–Sheffield experimental section and which is built wholly of mild steel.

Extra clearances are being provided on the towers carrying the larger conductors in order to permit the voltage to be increased possibly to 380–400kV in the future, should developments show this to be a practicable and economic method of providing further transmission capacity. The lines will be equipped initially with suspension strings of the conventional cap-and-pin insulators, and accommodation of all the additional units required for operation at 380–400kV would, according to the present state of knowledge, necessitate larger cross-arm spacing than that shown. But it is hoped that, by the time the need for a higher voltage is reached, advances in insulation technique will have led to an appreciable shortening of the string. Research on insulators of the rod type, and in the use of semi-conducting glaze, offers some promise of early progress in this direction.

The switching and transforming stations will broadly follow present practice on the existing grid system, most stations being laid out on conventional double-busbar lines. Owing to the greater spacing and clearances needed, and in order to keep structure heights within the economic range of reinforced concrete construction, the ground area required is very large. For instance, a station containing ten 275kV bays, with transformers and associated 132kV equipment, requires an area of about 12 acres.

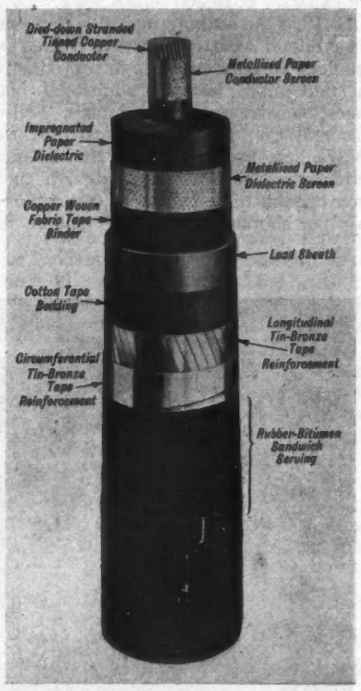
The 275kV switchgear will have a short-circuit rating of 7500MVA and current ratings of 800A and 1200A. Both air blast and bulk oil circuit breakers will be used, and provision will be made for high-speed automatic reclosing.

The transformers to be installed initially will be 120MVA, three-phase, star-connected auto-transformer units, stepping up from 132kV to 275kV. Voltage control will be provided by on-load tap-changing gear. The choice of 120MVA, three-phase units was governed largely by transport limitations, and the requirements of the scheme will involve double banking of these units at numerous points. For instance, it is envisaged that, in each of the main connecting stations for the London area, there will be six transformers in three banks to provide a gross transformer capacity of 720MVA.

Contracts have been placed for the bulk of the work in the 275kV grid scheme. The major works put in hand during the year ended March 31, 1951, comprised 371 route-miles of double-circuit 275kV overhead line, including sections of the first stage of the connections between West Melton (Sheffield) and Clyde's Mill (Glasgow), and between Tilbury and Elstree. Work was continued on the 41 miles of single-circuit 275kV line between Staythorpe (Newark) and West Melton, and the contract was approaching completion by the end of the year.

The major transmission works completed during 1951 included the new 132kV substation at Beddington, where fifteen of an ultimate twenty-four circuits of outdoor air-blast circuit breakers were brought into commission. Similarly, eleven out of fourteen circuits at a new substation at Bromborough were also completed, and substantial additions were made at Corby and Staythorpe with a view to connecting these substations to the main transmission system.

More than one British cable maker is actively engaged in the development and manufacture of cables for operation at 275kV, and during the year under review we had the opportunity of seeing an example of this class of cable being manufactured at the Erith works of British Insulated Callender's Cables, Ltd. As illustrated here-

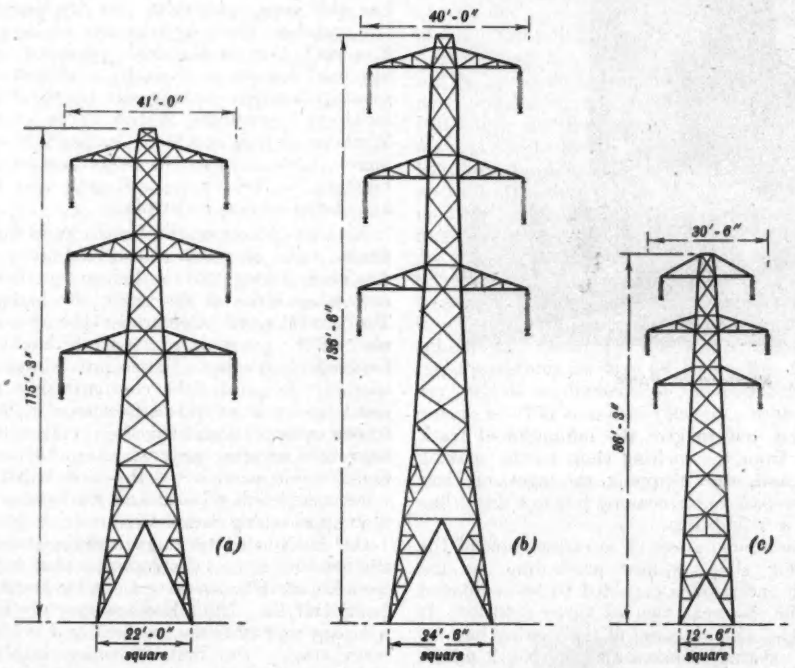


275 KV IMPREGNATED PRESSURE CABLE

with, it is an impregnated pressure cable, insulated with paper dielectric with nitrogen gas maintained at 200 lb per square inch inside the lead sheath. Details of the cable were published on page 769 of our issue dated June 8, 1951. Briefly, the conductor, of 0·75 square inch cross section, consists of ninety-one 0·103in tinned copper wires, died down and screened with metallised paper tapes. The radial thickness of insulation is 1·005in, made up of about 230 tapes of paper about 4 mils thick. A point of interest is the reinforcement necessary to withstand the gas pressure of 200 lb per square inch; the 1 per cent tin-bronze used for longitudinal and circumferential reinforcement tapes shown in our illustration provides the necessary combination of tensile strength and low electrical resistance to minimise losses. Overall protection against corrosion is provided by a serving consisting of alternate layers of rubber and compound fabric tapes, with an outside application of bitumastic compound.

The continuous rating of this cable, when installed under normal conditions direct in the ground, is 350A, corresponding to a three-phase load of about 250MVA.

(To be continued)



(*a*) 275kV double-circuit straight-line tower for twin 0·175 square inch conductors.
(*b*) 275kV double-circuit straight-line tower for twin 0·4 square inch conductors (designed for future operation at 380kV).
(*c*) 132kV double-circuit straight-line tower for 0·175 square inch conductors.

TOWER OUTLINES FOR 275KV AND 132KV SYSTEMS

SPECIAL WAGONS FOR SYNTHETIC SOAP PRODUCTS.—British Railways proposes to build 180 25-ton covered hopper wagons of a special type to carry sodium tripolyphosphate and soda ash in bulk from Cheshire to factories in the north west and eastern counties of England. Some 125,000 tons of this traffic is involved annually.

The British Iron and Steel Industry in 1951

No. II—(*Concluded from page 18, January 4th*)

THE modernisation scheme in progress at the Normanby Park Works, Scunthorpe, of John Lysaght's Scunthorpe Works, Ltd.—to which brief reference was made in our last issue—is based on the production of 7000 to 7500 tons of pig iron a week, with a steel ingot capacity of 10,500 tons a week. By the end of 1950 the soaking pits, blooming mill, billet mill and a battery of twenty-three coke ovens had all been brought into production.

In September last an additional blast-furnace, constructed by Ashmore, Benson, Pease and Co., Ltd., came into operation. It has a hearth diameter of 22ft 6in and is blown by a Richardsons Westgarth turbo-blower capable of delivering 65,000 cubic feet of air per minute at 18 lb per square inch pressure. A duplicate standby turbo-blower is to be installed during the present year. Adjacent to the blast-furnaces a Lodge-Cottrell electrostatic gas cleaning plant has been installed and was put into service last March. The plant is capable of dealing with 10,000 cubic feet of blast-furnace gas per hour, cleaning down to 0·007 grains per cubic foot. The old washing towers, adjacent to each furnace, have now been dismantled. Complete reorganisation of raw materials handling has been effected, the new system coming into operation when the blast-furnace was blown in last September. A stocking and reclaiming plant has been installed near to the existing ore crushing and sintering plants and, after treatment, raw materials are delivered direct to the blast-furnace bunkers or into stock by a belt conveyor system supplied by Mitchell Engineering, Ltd.

Some extensive alterations to the melting shop and ancillary services are in progress at the Normanby Park works, and during last year the first section of the melting shop reconstruction was completed. New arrangements for the handling of scrap include the construction of a gantry with three 10-ton electric overhead magnet cranes and marshalling sidings to facilitate handling to the melting shop. Raw materials are delivered to the charging bay on bogies with roller bearings and automatic couplings, each carrying four pans with an individual capacity of 30·5 cubic feet. The casting bay is now serviced by bogies fitted with roller bearings, each carrying four 4-ton ingot moulds, and fed to the parallel stripping bay by Hudswell Clarke diesel locomotives. This stripping bay came into commission last year. In it, two casts of ingots can be set for stripping simultaneously. It is serviced by two 6-ton electric overhead stripping cranes supplied by the Wellman Smith Owen Engineering Corporation, Ltd. For stocking, cooling, cleaning and changing of ingot moulds a mould conditioning shop has been erected parallel and adjacent to the stripping bay. The entire scheme has been carried out to give the minimum of track time from the melting shop to the soaking pits, and, after stripping, the ingots on their bogies pass to the soaking pits in a direct line over a weighbridge.

MELTING SHOP CASTING BAY, NORMANBY PARK

The second stage of reconstruction of the melting shop is now proceeding, at the south end, and is expected to be completed within the next two or three months. It includes the widening of the casting bay for four existing furnaces and the No. 2 mixer. Three of the furnaces are being rebuilt for a capacity of 120 tons, the fourth already being of that capacity. An accompanying illustration shows the wider casting bay, and in the foreground the first of three 175-ton ladle cranes supplied and erected by the Wellman Smith Owen Engineering Corporation, Ltd. The third stage, which will complete the melting shop reconstruction, will involve widening the centre portion of the casting bay, in front of three existing 120-ton furnaces. The melting shop will then contain nine 120-ton furnaces with two mixers, and will be capable of producing 10,500 tons of ingots a week.

To deal with the requirements of the new and existing plant the water supply services at the Normanby Park works are being reorganised and a new steam and electric power scheme is about to be undertaken.

Another reconstruction project which is in progress at Scunthorpe is that at the works of the Appleby-Frodingham Steel Company, which is a branch of United Steel Companies, Ltd., Sheffield. This scheme was started four years ago, the intention being to increase pig iron output. The ore preparation and sinter plants have been expanded, and before the end of the year a new battery of coke ovens was put into operation. One of our illustrations shows two of the blast-furnaces, Nos. 9 and 10, at the South Ironworks of the Appleby-Frodingham Steel Company. During the year one of the furnaces, No. 10, was relined and its hearth diameter increased from 22ft to 25ft, since when it has achieved very satisfactory outputs. Relining of the other furnace is to begin shortly. In addition, plans have been approved for the construction of two new blast-furnaces, Nos. 11 and 12, together with the necessary ore mining, ore treatment and blowing equipment. A phosphoric acid pickling plant for the surface treatment of steel was also installed last year, and additional facilities for normalising and finishing thin plates are now being constructed.

In other branches of the United Steel Companies, Ltd., there was continued progress last year on schemes of development and reconstruction. At the works of Steel Peech and Tozer, Rotherham, a central maintenance shop was completed and a new water purification plant was put into operation. A new stockyard for raw materials has also been completed. At Stocksbridge the stainless steel departments of Samuel Fox and Co., Ltd., were expanded and approval has been given to a project for constructing new soaking pits for the billet mill. Improvements at the works of the Workington Iron and Steel Company, Workington, include extensive alterations to the finishing banks of the rail mill and the installation of new boiler plant.

Another project of the United Steel Companies, Ltd., on which considerable progress was made during 1951, is the construction of new laboratories at Moorgate, Rotherham. The intention is to centralise the research work of the group in four separate blocks of buildings connected by corridor links of specially designed light construction. The new laboratories provide a floor area of about 60,000 square feet and have been built within an estate covering approximately 15 acres. Considerable portions of the new buildings were occupied last year, and the scheme is now approaching completion.

On the North-East Coast a major item in the steel industry's development plan is the work which is being carried out by Dorman, Long and Co., Ltd., Middlesbrough. That company's programme was arranged in three main stages, the first of which involved additions to and replacement of existing plant at the Cleveland and Redcar works. This stage was virtually completed about two years ago, when central ore unloading, ore preparation and sintering plant at the Cleveland works came into operation. The second stage of the Dorman Long scheme is the construction of a new open-hearth steel plant, designed for producing 500,000 tons of ingots a year, at Lackenby, a site of 650 acres linking the Cleveland and Redcar works. The plant is to be equipped with four tilting furnaces, each of 360 tons capacity, and two 600-ton mixers. Provision is being made for the subsequent addition of two or three more furnaces and another mixer. The company says that substantial progress was made last year at Lackenby, and that construction of the melting shop is now well advanced. One of our illustrations, reproduced from a photo-

BLAST FURNACES AT APPLEBY-FRODINGHAM WORKS

graph taken last autumn, shows the melting shop and ramp. The first structure to be completed at Lackenby was the stripper bay building and this is now in use as a fabricating shop in connection with the preparation of materials for other buildings. Other buildings which have been finished, but not yet equipped, are the stores, the machine shop and the canteen. Work is proceeding on an office block, and the foundations of the power-house have now been completed. In addition to the erection of the buildings, however, the project has entailed the laying down of an extensive system of rail tracks. The total amounts to about 25 miles, which includes an exchange siding grid to hold 457 wagons and which will be able to receive 1100ft trains from the lines of British Railways. It is anticipated that the Lackenby works will be operating before the end of this year.

Other work carried out by Dorman, Long and Co., Ltd., last year included some extensions to the boiler-house at the Cleveland works, and also the preliminary operations necessary for installing a pig casting machine. At the company's Britannia works two heavy roller straightening machines have been added to the equipment, and in the Acklam works melting shop a new 250-ton oil-fired tilting furnace has been built. At the Redcar works a new steel furnace of 90 tons capacity has been completed.

An important addition to the heavy forge facilities of this country was made last year by Hadfields Ltd., Sheffield. In November there was opened by H.R.H. The Duke of Gloucester, K.G., the forge which the company has constructed, as part of its development programme, at the East Hecla works. Its equipment includes two hydraulic forging presses, one of 2700 tons and the other of 1500 tons capacity, and the requisite reheating and heat-treatment furnaces. The forge, which is situated near to the steel-making plant and which is well placed in relation to the machine shops, has a content of about 8,800,000 cubic feet and occupies an area of 122,000 square feet. The building consists of four bays—the heat-treatment bay, furnace bay, forge bay and stock bay, the first three bays each having a crane span of 80ft with a height of 52ft from floor level to crane rail level, and a total length of 386ft. The fourth bay—the stock bay—is of the same length, but it has a crane span of 51ft 9in and a height from floor level to crane rail of 39ft 6in.

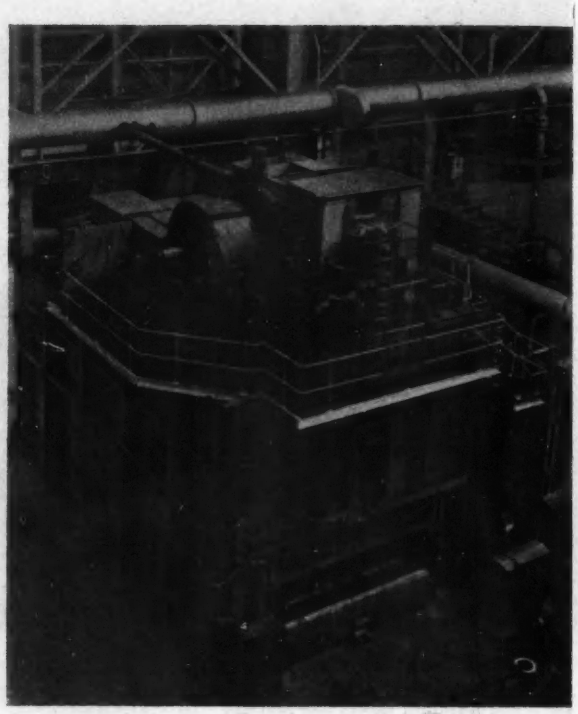
The forge has been designed to handle ingots up to 45 tons in weight and to produce forgings up to 40in diameter or up to 40ft long; it will produce rings up to 12ft in diameter and sleeves up to 6ft diameter and 10ft long. The ingots to be forged are normally transferred from the melting shops, in a hot condition, in covered bogies to the forge bay for immediate reheating. They are then forged under one of the presses and are afterwards usually taken hot to the heat-treatment bay for annealing. After annealing they are transferred to the machine shops for subsequent machining operations. One of the illustrations on page 68 shows the forge bay, which accommodates the two forging presses of 2700 tons and 1500 tons capacity. They were designed and supplied by the Loewy Engineering Company, Ltd., and were manufactured by F. B. Engineers, Ltd., and Light Machines, Ltd. One of the main points of this press plant is its high working speed and ease of operation over a wide range of forging work. To make that possible, and also to permit the greatest flexibility, it was decided to install an air hydraulic accumulator station in preference to a direct pump drive installation. Trial runs showed that penetration speeds of 6in per second or more could be achieved on both presses at full power, while during planishing or finishing operations well over 100 strokes a minute were maintained.

The forging presses are served by six bogie hearth and five fixed hearth reheating furnaces, and in the heat-treatment section there are nine bogie hearth furnaces and three tempering furnaces. The tempering furnaces have been installed for precise low-temperature treatments, within a range of 100 deg. to 750 deg. Cent., of the large and varied loads produced in the forge. These furnaces, one of which is illustrated on page 68, differ fundamentally from the usual, in that, instead of burners being used for heating the work chamber, the heat is generated in a combustion unit which is entirely separate from the furnace proper. To obtain the extreme accuracies and speed of heating at temperatures from 100 deg. to 750 deg. Cent. very large columns of gas are used as the heating medium and are continuously recirculated by fans through the furnace chamber in a closed system of ducting. To control the furnace temperature it is only necessary to regulate the temperature of this single body of main circulating gases by adding to them the small quantities of fresh gases being burnt in the external combustion chamber. The forge and its equipment were fully described in our issue of November 9, 1951.

In the North-West an interesting programme of extensions is being carried out at the works of John Summers and Sons, Ltd., Shotton, near Queensferry. It involves the construction of a large new blast-furnace and coke oven plant and of a new melting shop. Good progress was maintained on this scheme during last year, and the new melting shop is expected to come into part production before very long. It is anticipated that the new

MELTING SHOP AND RAMP AT LACKENBY

FORGE BAY, EAST HECLA WORKS



TEMPERING FURNACE, EAST HECLA WORKS

blast-furnace will be operating before the end of this year.

Some new works which are being carried out at Bidston Dock, Birkenhead, although not part of the steel industry's development plan, have a distinct bearing on the Shotton project.

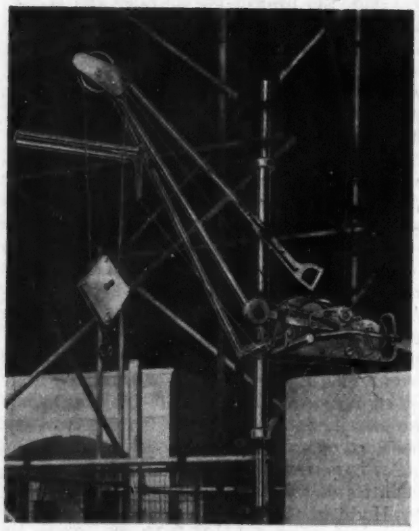
At the western end of the Birkenhead Dock system the quay and land on the north side of Bidston Dock are being developed for discharging increased imports of iron ore. The berth will eventually handle about 1,500,000 tons of iron ore per year and is intended primarily for supplying the new blast-furnace plant being erected for John Summers and Sons, Ltd. The quay is 1000ft long and two ships of 8000 to 10,000 tons deadweight capacity can berth alongside at the same time. In the first instance two electrically-operated travelling transporters, each with a capacity of 350 tons per hour, will be installed, but at a later date two additional transporters will be provided. The grab on each transporter has a capacity of 6½ tons and will normally discharge ore into hoppers on the transporter structure. Arrangements have been made, however, for the grab to discharge the ore direct into a stockpile at the back of the quay or into barges lying on the far side of the ships. The ore in the transporter hoppers is delivered into wagons of 25 ton and 50 ton capacity running on four sets of railway lines on the quay. Marshalling sidings with weighing facilities and room for 344 25-ton wagons are also provided and will connect with the Seacombe to Wrexham section of British Railways, thus affording a direct run to the steel works about 14 miles away. The front legs of the transporters run on double rails supported by a foundation in the form of a continuous counterfort on the back of the existing concrete dock wall, whilst the rear legs run on double rails on a concrete foundation supported by two continuous lines of sheet piling about 5ft apart. The electric supply to the transporters is provided by a pick-up running between a continuous chase in the top of an underground cable trench. The chase, which is 10½in wide and is covered by a flexible sheet steel plate, is automatically raised up when the transporters travel along the track. The existing concrete decking has also been widened to accommodate four lines of railway tracks and suitable cross-overs have been provided for shunting purposes. Work on the project is well advanced and the scheme, which is due to commence operating early next year, should materially affect the volume of iron ore imported at Birkenhead. The transporters are being built by Joseph Booth and Bros., Ltd., for the operators of the berth, Rea Ltd. The alterations to the quay and the provision of the sidings are being undertaken by the Mersey Docks and Harbour Board.

Other schemes which should assist the efficiency of the iron and steel industry are those put in hand by the National Coal Board for the erection of coke oven plant. Last September, at Nantgarw, in the South Wales coalfield, there was opened a coke oven and by-product plant which will provide first-grade coke for blast-furnace use. The cost of the scheme is put at about £3,000,000, and in its final form the coke oven plant has been designed to carbonise 1500 tons of coal a day, giving a daily output of about 1100 tons of coke. Another coking plant, consisting of 106 ovens, is to be erected by the National Coal Board at Wingerworth, near Chesterfield, the main contract in connection with the scheme having been placed last October.

A Builder's Winch

WE reproduce on this page a photograph of a small winch, which was recently developed by A.C.E. Machinery, Ltd., of Porden Road, London, S.W.2, for use on building sites. The unit is supplied complete with a kingpost by which it is quickly and easily clamped on to standard tubular scaffolding. It has a lifting capacity of up to 5 cwt and its hinged tubular jib can be adjusted through a supporting strut to give different working radii up to 5ft. The kingpost is mounted on ball bearing races on the main support column of the unit, which can be slewed through a complete circle together with a load.

The winch hoist is driven through a three-speed gear and the drive can be either a 1½ h.p. electric motor or a small internal combustion engine. Hoisting speeds from 45ft to 175ft per minute are available through the three-speed

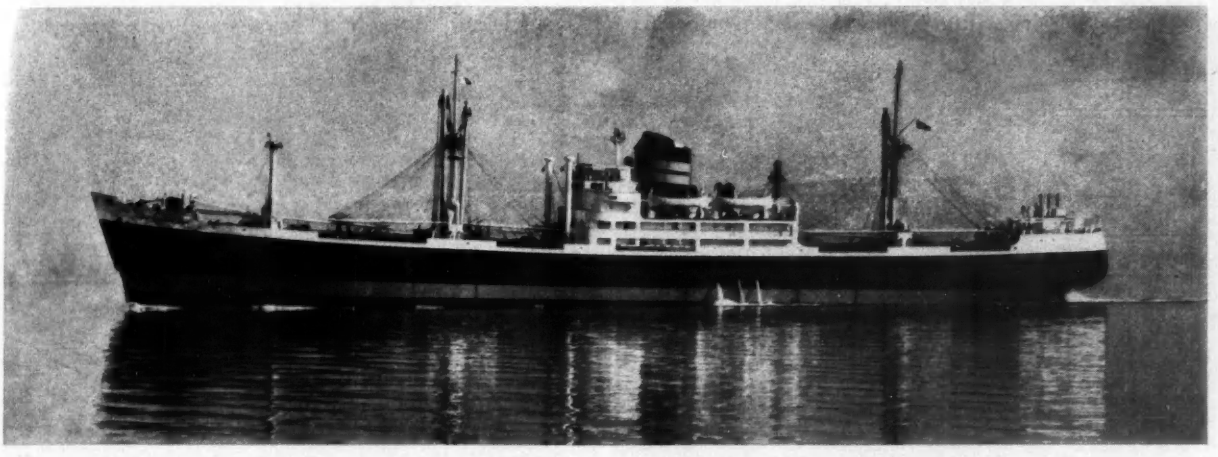


BUILDER'S WINCH

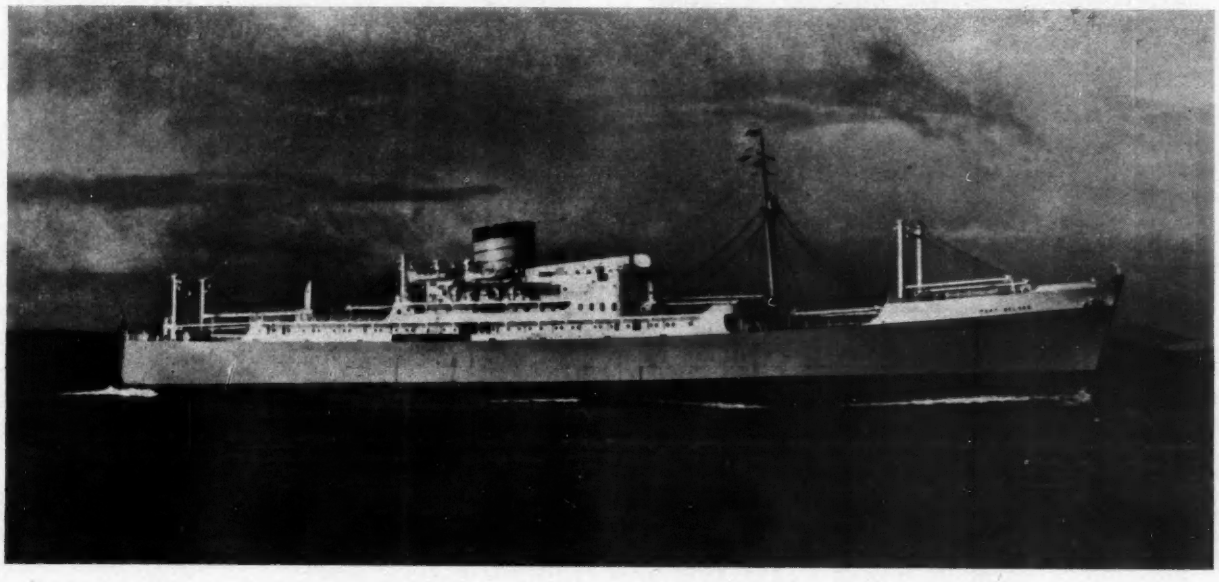
gear, and weights from 1 cwt to 3 cwt can be lifted on a one-part or up to 5 cwt on a two-part rope.

To prevent overwinding of loads a self-resetting safety gear is fitted. This gear consists of a hinged frame fitted near the top of the jib with a lever depending from it connected by cable to the winch control lever. When the hook assembly is overwound pegs projecting from its body contact the frame, which, as it lifts, pulls on the release cable to disengage the drive through the control lever. A single weighted control lever is used and when it is released by the operator the hoist drum automatically takes up its stop position.

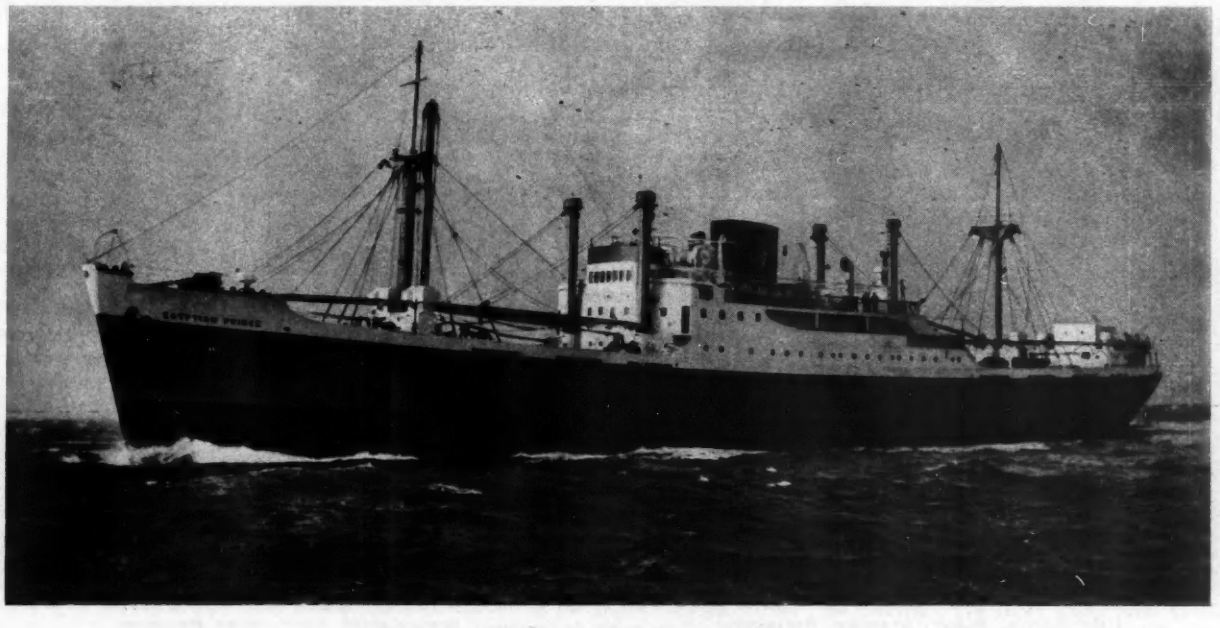
MERCHANT SHIPS OF 1951



CLAN LINE "CLAN SUTHERLAND"

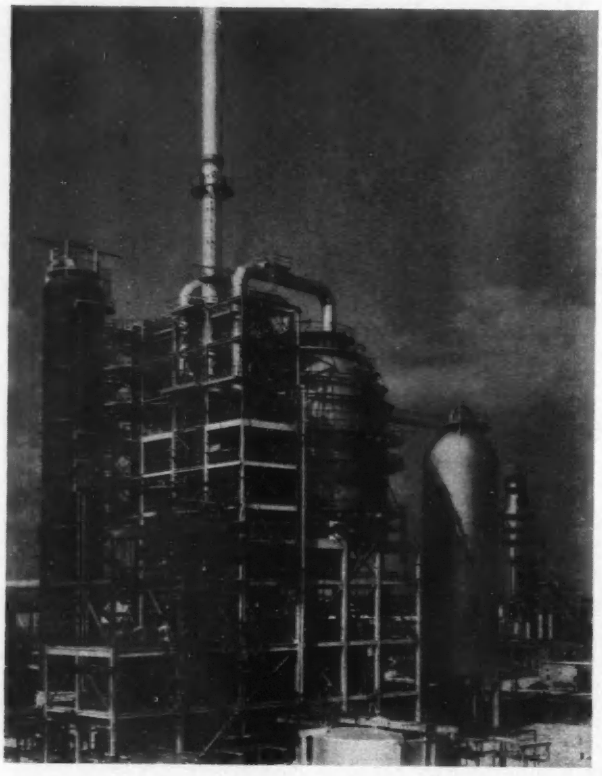


PORT LINE "PORT NELSON"



PRINCE LINE "EGYPTIAN PRINCE"

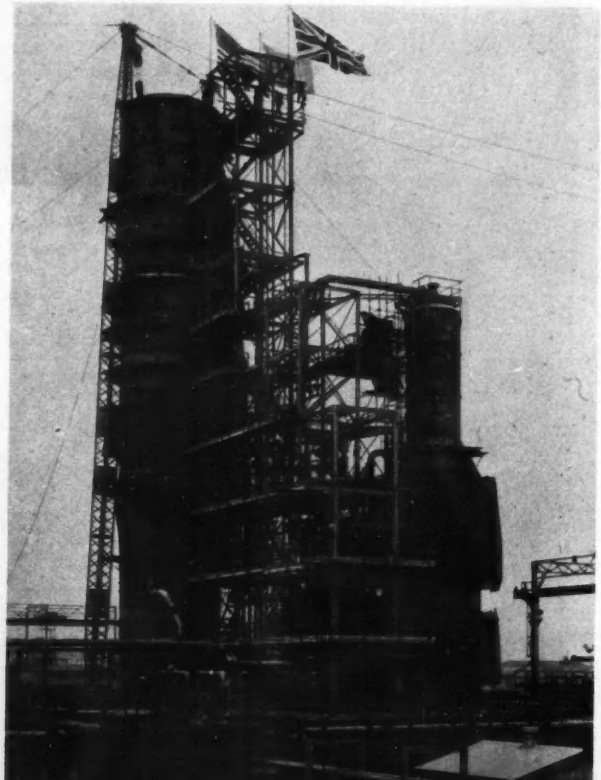
OIL REFINERIES OF 1951



CATALYTIC CRACKING PLANT, FAWLEY REFINERY

SIDESTREAM UNIT AND TOPPING WASHERIES, GRANGEMOUTH REFINERY

DISTILLATION PLANT, STANLOW REFINERY



DISTILLATION UNIT, KENT REFINERY

Shipbuilding and Marine Engineering in 1951

No. II—(*Continued from page 36, January 4th*)

British Shipbuilding Research

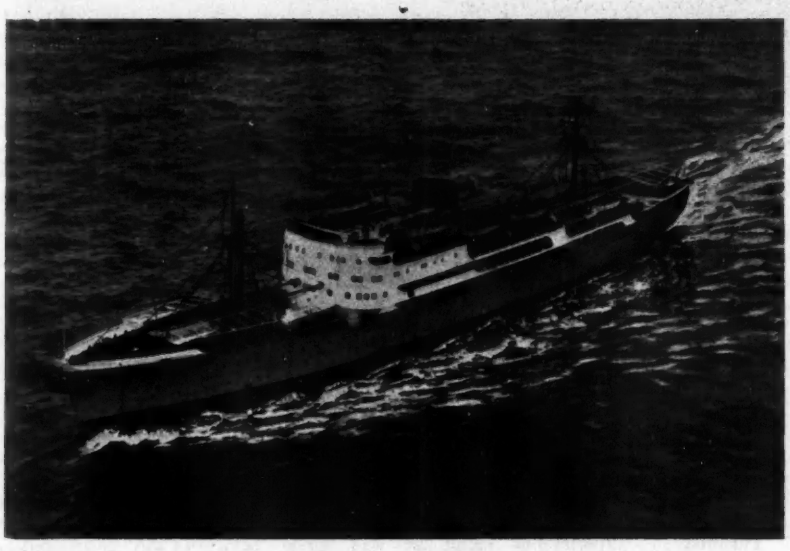
CONTINUED progress was made at PAMETRADA under its director, Dr. T. W. F. Brown, who paid a visit to the United States, where he inspected progress in turbine construction at various works and read a paper before the American Society of Mechanical Engineers. The staff was increased by the inclusion of a group of engine testers, and during the year the research house extension was completed and the new workshop put into operation. More than two-thirds of the geared turbine machinery built by member firms was designed by the Association, and the most important development in component design was the method of manufacturing diaphragms and blading for impulse turbines. The strength and stiffness were verified and the diaphragm adopted for machinery using steam at 650 lb per square inch and 850 deg. Fah.

Investigations into scuffing in gearing continued and a new torsiograph, which can record vibrations at four separate points simultaneously, was developed to investigate one-node torsional critical speed.

Attention was focused upon the theoretical development of gearboxes capable of driving ahead or astern, in which two annulus members may be stopped by hydraulic brakes. The trials of destroyer machinery made progress, the report on the "Daring I" was completed, the trials of the "Daring II" were completed, and those of the "Daring III" machinery, which is of all-impulse design, were put in hand. Associated with the machinery trials, heat transfer coefficients in condenser tubes were investigated and the steam pressure drop can now be measured accurately. A method using a "Thermistor" device to measure the water temperature rise was devised and a spark gap indicator designed to measure the relative expansion between rotor and casing. The calculations of turbine diaphragm deflections and strains were confirmed by a test in which hydraulic pressure simulated steam loading.

Transmission research continued and a back-to-back test was carried out on Maag gearing, which consists of two-cylinder, double-reduction locked train gears, air hardened and ground, of single helical design. The back-to-back tests to destruction yielded useful data and a 4000 h.p. set of hobbed gears without helix correction were run to destruction, while a similar set of gearing, with helices corrected for torsion and bending, were loaded up to 325 per cent without failure. Following upon tests on hydraulic reversing mechanisms, an astern converter type "A" was tried and astern converter type "B," which incorporates modifications to reduce hydraulic losses, is in course of manufacture.

During the year the instruments required for the investigations continued to be developed and improved. A final model of the electronic torsio-axial pick-up for measuring the frequency and amplitude of torsional vibration of turbine shafts and secondary shafts was under construction. A technique was developed for welding fine strain gauge wires and, for the calibration of microphones, a taper duct was built for dealing with the lower end of the frequency scale, while for the higher ranges a cabinet was constructed.



Motor Vessel "India"

Technical Papers

In addition to the reading of papers before the various technical societies, there was held in this country an International Conference of Naval Architects and Marine Engineers, which was attended by delegates from fourteen countries. The conference opened in London and the delegates subsequently visited Glasgow and Newcastle upon Tyne. Eight papers were read in London, including "British Shipbuilding Research Association, Resistance Experiments on the 'Lucy Ashton,' Part 1: Full-Scale Measurements," by Sir Maurice Denny, to which we have already referred. Mr. R. B. Shepheard gave a historical review of the advances in construction in his paper, "Ships' Structures—A Century of Progress." Monsieur Blanchard, in his paper "Characteristics and Developments of Naval Fuel Oils" discussed the effect of sulphur and sodium, and the pumping of fuels at low temperatures. With reference to the growing dependence upon Middle East fuel supplies, he said that tests indicated that a sulphur content of 3·5 per cent was the maximum which could be tolerated.

In "Ship Motions," by Mr. John C. Niedermair, recent knowledge concerning the six oscillatory motions of ships at sea were reviewed and new experimental data presented. The results of model tests, related to certain of the motions, were correlated with recent theoretical findings and found to be in general agreement. This paper, entitled "Proposed Design of a Combined Research Training and Cargo Ship," by Professor Ir. H. E. Jaeger and Ir. J. C. Arkenbout Schokker, discussed the salient points of a ship specially designed for investigation into ship construction and propulsion problems and for the training of boys. Mr. N. G. Eckerbom, in his paper "Some Aspects of Prefabrication in Ship Construction," discussed the prefabrication problems which have arisen due to the rapid adoption of this method for building a ship. The author dealt with one particular shipyard and described the unit storage area and the assembly area, which consists of three separate areas. The necessity of a well-controlled flow of steel was stressed and also that the assembly area is the keypoint of production.

"Higher Steam Conditions for Ships' Machinery" was the title of a paper given by Messrs. M. L. Ireland, jun., H. W. Semar, and N. L. Mochel. The authors dealt with problems in the selection and application of cycle components and high temperature materials for geared turbine machinery. Advances in steam conditions were such that it was necessary to strike a balance between fuel savings, weight saving and increased first cost when determining suitable conditions. The selection of machinery components was reviewed together with factors concerning feed temperatures, while for pressures exceeding 600 lb per square inch attention was called to the development of the double compound feed pump having two high-speed impellers operating in series. The effect of creep at high temperatures upon working stresses and factors of safety was given consideration and, besides giving hoop stress formulæ, stress margins were linked with the metallurgical aspect. The paper entitled "Boiler and Turbine Testing," by Captain (E) L. F. Ingram, R.N., and Captain (E) L. A. B. Peile, R.N., defined the four categories of machinery testing and discussed the advantages of trials afloat and ashore. Data from the latter formed the basis of the paper and referred to the boiler and turbine trials of the machinery for a "Daring" class destroyer.

Another engineering paper, entitled "Stresses in Propellers and Propeller Shafting Under Service Conditions," was read by Dr. S. F. Dorey at Newcastle upon Tyne. A number of problems encountered by Lloyd's Register and solved by electronic methods were described and further fields for investigation were suggested. A method for measuring stresses in propeller blades was described by Dr. Dorey, who reviewed the stresses in shafting and also the experiments with a tug and a Great Lakes oil tanker. Another interesting piece of equipment described by the author was a simple high sensitivity strain gauge giving direct measurement of cyclical bending stresses from which horizontal and vertical misalignment can be derived. The other paper read at Newcastle was given by Captain Ralph K. James, U.S.N., and entitled "U.S. Fleet Mainten-

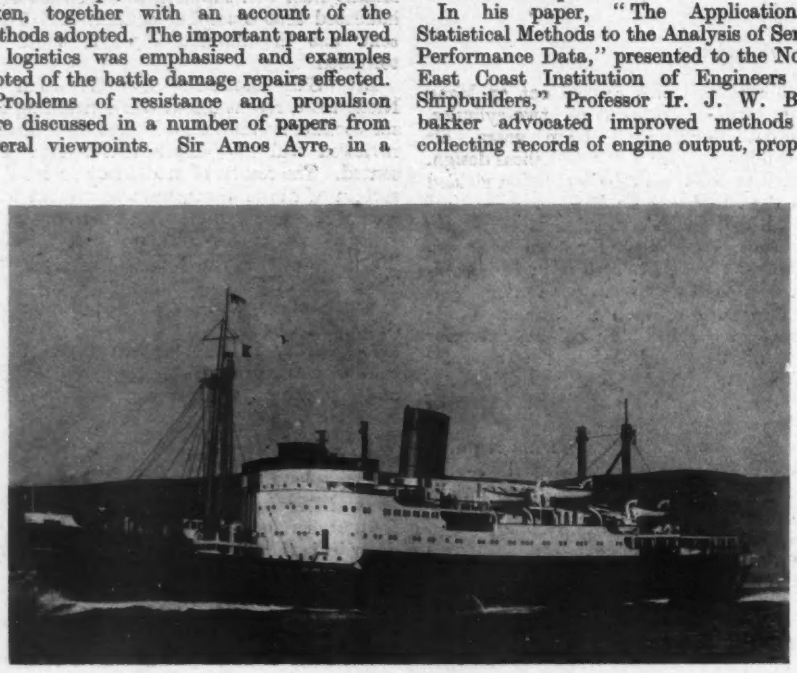
ance and Battle Damage Repairs in the Pacific During World War II." This paper described the immensity of the task of providing sufficient and adequate repair facilities for naval ships, and the two main courses taken, together with an account of the methods adopted. The important part played by logistics was emphasised and examples quoted of the battle damage repairs effected.

Problems of resistance and propulsion were discussed in a number of papers from several viewpoints. Sir Amos Ayre, in a paper, "Some Observations Concerning Resistance and Propulsion," read at the spring meeting of the Institution of Naval Architects, called for a standard form of presentation of tank results, and also the standardisation of the length dimension so that the longitudinal centre of buoyancy could be fixed and differences in the block coefficient avoided. Many other factors were reviewed, such as the need for a conventional method of measuring the angle of entrance, propeller tip clearance, propeller diameter in relation to the breadth of the hull, and the desirability of dropping the term quasi-propulsive coefficient. In another paper, "Further Ship Resistance Similarity," Professor E. V. Telfer re-examined the basic principles of resistance similarity and gave the relationship in a new form which resulted in an extension of the Froude Law. The extrapolator problem was considered and the application of the principles to surface roughness was linked with seam and butt roughness, while the paper showed that basic Froude methods were capable of rational development.

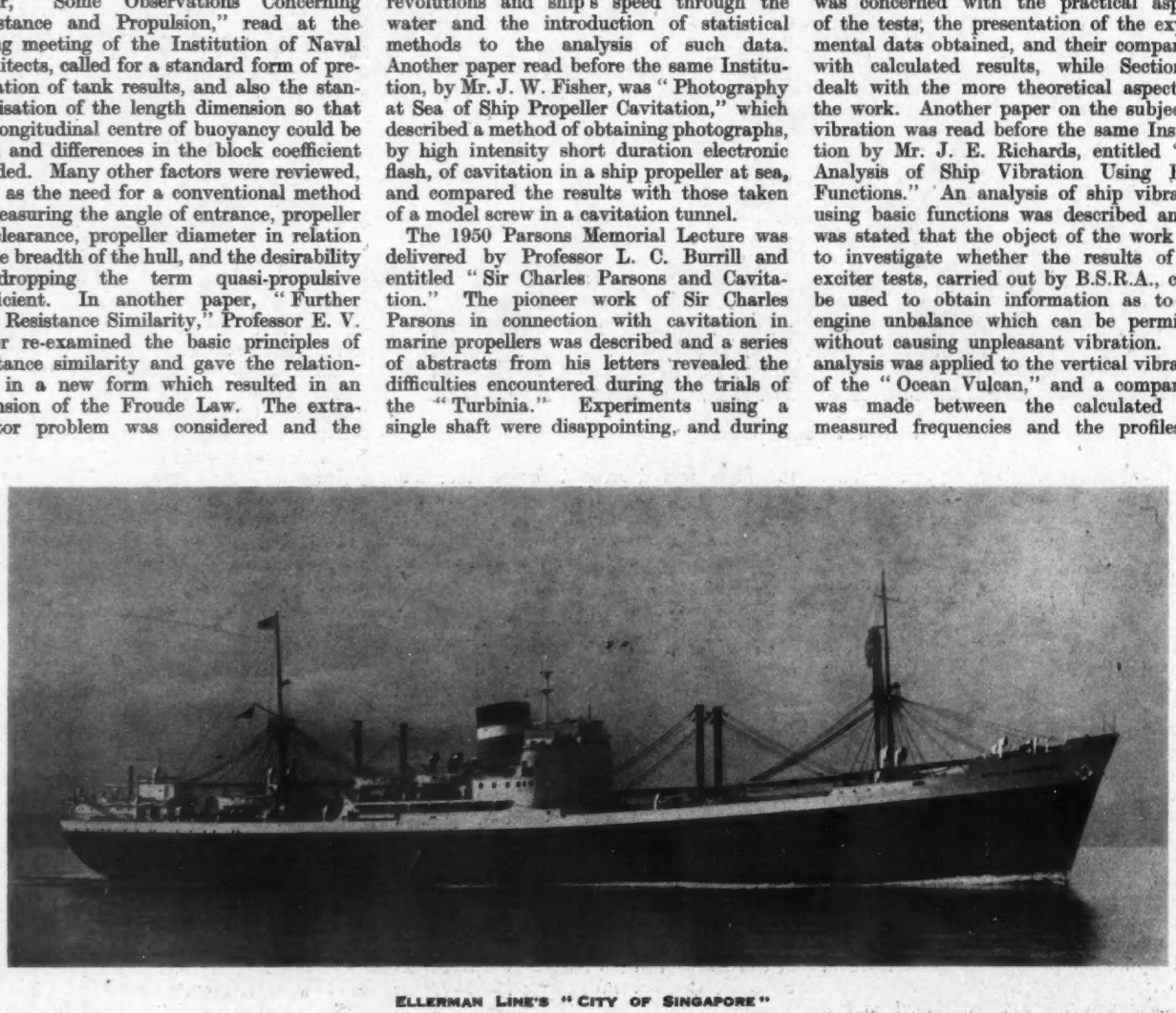
In his paper, "The Application of Statistical Methods to the Analysis of Service Performance Data," presented to the North-East Coast Institution of Engineers and Shipbuilders," Professor Ir. J. W. Bonebakker advocated improved methods for collecting records of engine output, propeller revolutions and ship's speed through the water and the introduction of statistical methods to the analysis of such data. Another paper read before the same Institution, by Mr. J. W. Fisher, was "Photography at Sea of Ship Propeller Cavitation," which described a method of obtaining photographs, by high intensity short duration electronic flash, of cavitation in a ship propeller at sea, and compared the results with those taken of a model screw in a cavitation tunnel.

The 1950 Parsons Memorial Lecture was delivered by Professor L. C. Burrill and entitled "Sir Charles Parsons and Cavitation." The pioneer work of Sir Charles Parsons in connection with cavitation in marine propellers was described and a series of abstracts from his letters revealed the difficulties encountered during the trials of the "Turbinia." Experiments using a single shaft were disappointing, and during the next three years many propeller arrangements were tried before the final result was achieved with nine propellers on three shafts. Cavitation experiments in 1895, which included the making of the first small cavitation tunnel, were described and photographs showed the nature of the phenomenon. The first large cavitation tunnel was built at Wallsend in 1910. Details hitherto unpublished were given of work carried out in the tunnel with systematically varied propellers and the method of presentation adopted by Sir Charles was discussed. A brief description was given of the work which proved that the erosive action of cavitation was mechanical and not chemical, and details of tests with propellers for Atlantic liners which showed the correspondence between photographs of models working in the tunnel under vacuum and the erosion which occurred in service. The modern approach to cavitation problems and the developments which have taken place were reviewed and it was demonstrated that the main conclusions at which Sir Charles had arrived are still valid to-day.

Early in the year Mr. A. J. Johnson read a paper before the North-East Coast Institution of Engineers and Shipbuilders with the title "Vibration Tests of All-Welded and All-Riveted 10,000-Ton Dry Cargo Ships," which described the work on ship vibration carried out by the British Shipbuilding Research Association on two standard 10,000-ton dry cargo ships, the "Clan Alpine" and the "Ocean Vulcan," of riveted and welded construction respectively. The paper was divided into two main parts. Section A was concerned with the practical aspects of the tests, the presentation of the experimental data obtained, and their comparison with calculated results, while Section B dealt with the more theoretical aspects of the work. Another paper on the subject of vibration was read before the same Institution by Mr. J. E. Richards, entitled "An Analysis of Ship Vibration Using Basic Functions." An analysis of ship vibration using basic functions was described and it was stated that the object of the work was to investigate whether the results of the exciter tests, carried out by B.S.R.A., could be used to obtain information as to the engine unbalance which can be permitted without causing unpleasant vibration. The analysis was applied to the vertical vibration of the "Ocean Vulcan," and a comparison was made between the calculated and measured frequencies and the profiles of



UNION STEAMSHIP COMPANY'S "TOFUA"



ELLERMAN LINE'S "CITY OF SINGAPORE"

vertical vibration for five conditions of loading. Agreement was obtained between calculated and measured vibration profiles and two-node frequencies, but discrepancies between the calculated and measured frequencies of the three and four-node modes of vibration were shown, by additional tests, to be caused by the superimposed vibration of the double-bottom structure loaded with entrained water.

The twentieth Andrew Laing Lecture, upon the subject "Shortcomings of Structural Analysis," was delivered by Professor J. F. Baker before the North-East Coast Institution of Engineers and Shipbuilders, and an abstract appeared in THE ENGINEER, December 7, 1951.

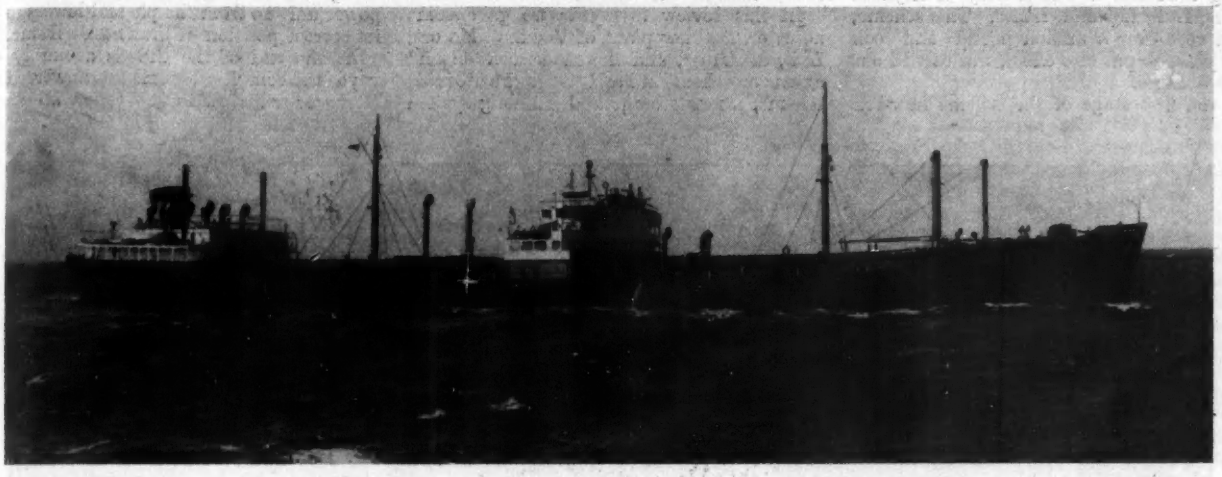
"Stress Analysis Using the Brittle Lacquer Process," was the title of a paper given by Mr. K. C. Rockey before the Institute of Marine Engineers. The process, which enables qualitative and quantitative results to be obtained, was described together with its development as a tool of the stress analyst. Other papers read before the Institute included "Marine Torsionmeters and Thrustmeters," by Mr. R. Cook, in which he discussed the general requirements of torsionmeters and thrustmeters, together with the difficulties in their design. The various forms of torsionmeter were surveyed and the results given of investigations into the degree of accuracy obtainable. Mr. B. Taylor, in his paper "Automatic Combustion Controls for Marine Boilers," gave a comprehensive survey of the subject of automatic controls for the regulation of air and fuel supplies to boilers. The possible advantages from the use of such systems were discussed and the principal elements of control systems, together with various possible arrangements, were considered.

Before the Institution of Engineers and Shipbuilders in Scotland, Mr. A. B. S. Laidlaw read his paper, "Selection and Application of Oil Burners," in which he discussed the selection of the most suitable design of burner and gave examples of burner application to various classes of boiler and to different classes of furnaces. There was read also a paper entitled "Some Aspects of Research on Friction and Wear," by Dr. F. T. Barwell, who described the mechanical, physical and chemical means for examining surfaces, to obtain a knowledge of the state of the surfaces involved in the rubbing process, as a prerequisite for the study of friction and wear. Fretting corrosion was discussed and the advantages of artificial protective films, while the need for careful design of high-speed bearings was emphasised if excessive loss of power due to viscous friction was to be avoided. Experiments illustrating the existence of vortices at high speed were described, the measurements on thrust bearings operating at 5000 r.p.m. given, and the problems concerning high speed ball and roller bearings were discussed.

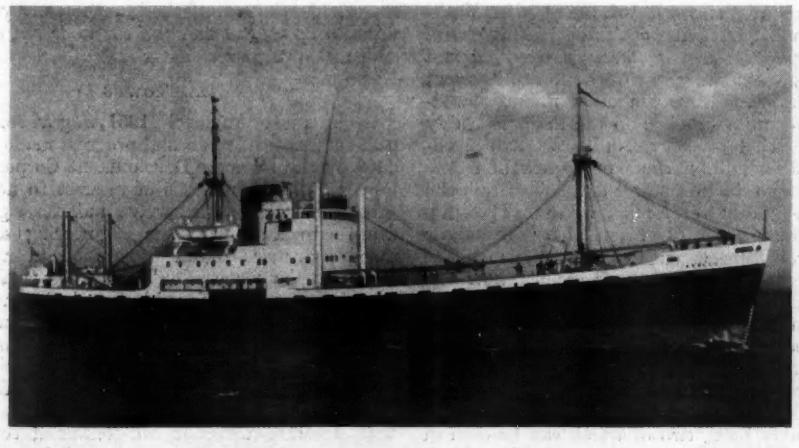
The work carried out by the British Shipbuilding Research Association to assess the conditions in machinery spaces was described in a paper entitled "The Improvement of Environmental Conditions in Ships' Machinery Spaces," which was read by Mr. S. A. M. Davidson and Dr. M. Fishenden before the North-East Coast Institution of Engineers and Shipbuilders. The paper gave the maximum temperatures which engine-room staff should be able to stand without undue discomfort or loss of efficiency, and also the results of an investigation into machinery space conditions of several merchant ships. The detrimental effect of hot surfaces and of moisture escape were noted and tests carried out to discover how to reduce these sources of heat were described.

Several papers given before the Institute of Marine Engineers considered the question of materials. Mr. L. W. Johnson and Mr. E. J. Bradbury, in their paper "Corrosion-Resistant Materials," discussed the various forms of corrosion to which metallic materials are subjected and surveyed the main corrosives as well as the effect of other influences. "Refractory Materials for Marine Boilers" was the title of a paper read by Mr. F. H. Clews, in which he discussed refractory failure resulting from liquefaction, fracture and shrinkage, and described the properties of various firebricks and refractories. Mr. M. M. Hallett, in his paper "Ductile Cast Iron," gave the reason for the good properties of spheroidal graphite cast iron and stated that when the change in graphite type coincided with changes in the matrix of the iron, the iron produced has high-tensile strength and three times the toughness of engineering cast iron. Foundry characteristics and machinability were discussed, together with the lines of application. "Gamma Radiography in Shipbuilding and Engineering" was the title of a paper given by Mr. J. D. Hislop, who mentioned the ease with which artificial radio-active substances were made available from the Harwell Atomic Energy Research Establishment. The introduction of cobalt, tantalum and iridium rendered radium obsolete, and the author discussed gamma-radiographic technique and application together with the problems of safe handling.

(To be continued)



AFRICAN TRANSPORT CORPORATION'S "MAGWA"



ELLERMAN'S WILSON LINE'S "CAVALLO"

WATER-BORNE "PETROL TRAIN."—Six oil barges, each of 200 tons capacity, have arrived at Lagos, Nigeria, for the distribution of petrol in bulk to the French Northern Cameroons and to the interior of Southern Nigeria. The scheme, developed by the Shell and Socony Vacuum oil companies, includes the construction of four bulk depots, and the barge train, which will be propelled by a twin-screw, diesel-engined tug, will be operated by the United Africa Company, Ltd.

British Workshops in 1951

No. II—*(Concluded from page 33, January 4th)*

Motor Vehicle Works

THE demand for British-built road transport vehicles remained at a high level during the year and a number of well-known manufacturers carried out extensions and works reorganisation and modernisation schemes to increase their output still further.

One such case of reorganisation and modernisation dealt with in THE ENGINEER during 1951 was at the factory of Leyland Motors, Ltd., Leyland, Lancs. This scheme, which cost over a million pounds and took three years to put into effect, was carried out in three stages.

In the first stage of the scheme flow-line production methods were introduced into the machine shops engaged in making component parts, and in the second stage new erection methods were introduced in the sub-assembly sections building the units. Production on the conveyors on which the sub-assemblies are built is linked up with the flow of the main assembly conveyor. The system laid down ensures that only those units are produced which will be used immediately in chassis assembly, and the amount of stock in the sub-assembly stages and on the shop floors is kept to a minimum.

For the chassis assembly conveyor system there are three parallel lines of conveyors having effective lengths of 250ft, 350ft and 300ft respectively and each runs at a maximum speed of 5ft per minute. After the first stages of chassis assembly have been carried out on the floor the assembly is put on the head of the first conveyor with its front and rear axles resting on cradles. From the foot of the first conveyor the assembly is transferred to the head of the second conveyor by overhead crane and again from the second to the third conveyor by another crane. During the passage along the first and second conveyors the engine, gearbox and other preassembled units are fitted. On the third line painting is done, points are pressure greased and major units, such as gearboxes and back axles, are filled. When the cabs and the wheels have been fitted the chassis are run off the line and are driven straight to the running shop and test bay. Throughout the conveyor lines the assembly stations are equipped with power-operated tools and other mechanical facilities to speed work and reduce manual effort to a minimum.

In this review last year we gave some notes on the new plant of Vauxhall Motors, Ltd., at Luton, and the modernisation and extension scheme in hand there. Part of this scheme, a new storage and handling system for the wheels and tyres of commercial vehicles, was put into service early in 1951. This plant has been laid down at the end of the vehicle assembly line and is arranged to prepare 1000 complete wheel assemblies daily. Its lay-out and operation were described in our issue of May 11th last.

A new assembly plant which went into service at the works of the Austin Motor Company, Ltd., at Longbridge, Birmingham, incorporated a new conveyor handling and storage equipment with a control system which practically eliminated manual handling of units supplied to the main assembly lines. Under this system storage and mechanical handling are combined, and the transfer of bodies, power units, &c., from the sub-assembly to the main assembly lines in a new building is synchronised by switchgear controlled by punched cards. In our issue of September 7th last we described how the conveyors feeding the units to the main assembly lines move up automatically as a component is removed and the parts are fed in their correct order as assembly of a vehicle proceeds.

In this new plant there are three main assembly lines, two of which can be seen in the upper illustration on page 73. Each line starts as a steel slat conveyor with fixtures to carry the cars and all their parts at suitable intervals. These conveyors start in the stores, where all the necessary parts are laid on in sets in predetermined places. As the conveyors emerge from the stores into the assembly shop the chassis frames are lowered on to fixtures and the assembly operations commence.

The chassis frame moves along the conveyor as assembly proceeds, and when it reaches a point directly above the axle pit an elevator brings up the front suspension units and the rear axle, and lowers them into position automatically. A little further along the line another elevator brings the power unit up from the pit and lowers it into its correct position in the chassis frame.

At the end of the chassis assembly conveyor the completed frame is transferred to a conveyor which takes it through an electro-static spray painting booth and a drying oven. The chassis is then transferred to the body mounting conveyor, the elevator of which brings up the appropriate body from the pit below and places it in position. Then, after the wheels have been fitted, each car is carried on its own wheels on an elevated twin slat conveyor through the final assembly stages. At the end of the line the conveyor sinks to floor level and the car is driven off under its own power.

CHASSIS ASSEMBLY LINES AT LEYLAND WORKS

The New Towns

In our issue of August 21, 1951, we gave some particulars of the plans and progress made to date by the Crawley Development Corporation in Sussex, and it is of interest to note that during the past twelve months eight firms associated with the engineering and allied industries began production in new works on the corporation's industrial estate. The background and objects of the new towns, such as that at Crawley, are now generally known. The new towns around London are being built to relieve congestion in the Greater London area by providing London people, industries and businesses with accommodation in self-contained communities, where a balance is struck between

domestic facilities and establishments providing employment. The advantages of these new towns are many, for not only do they help to relieve the housing problem and the overloaded transport system in the metropolitan area, but they also reduce to a large extent the time wasted in travelling to and from work, and provide healthy surroundings both living, and working.

The industrial estate is developed by the corporation which owns the freehold and leases building sites or factory premises to industrial firms. Each firm must obtain its own Industrial Development Certificate from the Board of Trade, London Region, and must apply for its own building licence. Firms wishing to build their own factories may take ninety-nine years' building leases of sites developed by the corporation, while for firms who wish to rent factory buildings the corporation is prepared to erect standard unit factories or individually designed factories of a reasonably standard character under the building licence obtained by the firm to which an occupation lease is granted.

Housing for the London employees of these firms is provided by the corporation and let to the employees individually, the occupation of dwellings by the firms' employees being arranged to take place over a period of months related to the date at which the new factory is likely to be completed. We were informed at Crawley that the firms which had already moved had found that about 80 per cent of their London staffs wished to move with them. Labour lost in the transfer is made good by replacements from members of a family, one of whom has been primarily concerned in the transfer of another firm, and from lists provided through the Ministry of Labour Employment Exchange of Londoners on the London housing lists willing to settle and work in the new town. Although some of the new works have been open only a few months, it was stated that production efficiency had increased with new plant lay-outs and the introduction of methods for which the original premises in London were not suitable.

In considering applications from firms interested in moving out to Crawley the Development Corporation has regard to the general industrial structure which is being built up in the town, both from the point of view of reasonably maintained employment in varying market and trade conditions, and the balance of employment as between men, women and juveniles. The corporation also regard it as important that there should be a reasonable field of employment for the various trades and skills within the engineering and other industries represented in the town in order to obviate the possibility of an employee who leaves or is discharged by a firm being stranded in an area remote from works where his class of skill is required.

The first group of seventeen standard factories at Crawley has been completed and leased to thirteen firms. The standard factories in the first group are built in units of 3500 to 6300 square feet, each being 40ft wide and divided into five or six 20ft bays with a clear height under the beams of 12ft. The reinforced concrete stanchions and beams of each unit support a barrel vault concrete roof, in which top lighting is arranged to give a daylight factor of about 20 per cent inside the building. A high degree of heat insulation is provided by lining internally with insulating board and covering the outer surface with felt. Along the front of the building is a flat-roofed section, 8ft high, which can be divided as required to provide offices, cloakrooms, &c. At the rear of the building is an enclosed storage and delivery yard with access to the workshop through 7ft 7in high, 9ft 6in wide doors, which, if necessary, can be increased to 11ft 7in high. The wide floor space, being clear of any obstruction, facilitates the arrangement of plant to suit any particular production flow. The second group of standard factories which the Crawley Corporation will start to build in the spring of 1952 will be similar in character, but with a larger overall area of up to 7600 square feet. The additional space will be devoted to the office and cloakroom blocks at the front and sides, because it has been found that most firms can use rather more office accommodation than was provided in the first group of factories.

In the new factories the electricity supply is taken from a 240/415 four-wire cable arranged as a channel ring main which can be altered or extended to suit requirements. The soffit of the valley beam crossing the main 40ft bay at every 20ft in a unit factory is arranged so that overhead services can be fixed to connect the ring main round the perimeter of each main bay. A gas supply ring main is arranged adjacent to the channel conduit and from it branches can be taken to process equipment.

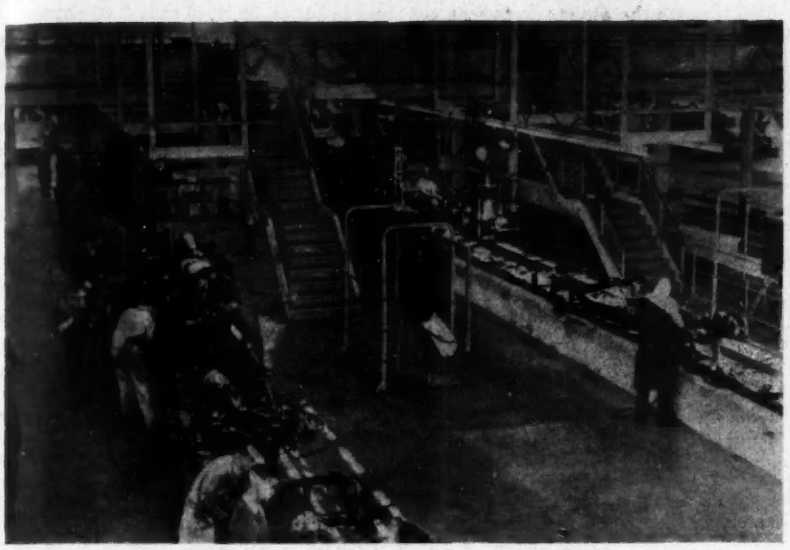
These factory units can be taken by firms in blocks of one, two, three or more according to the amount of space required, and if at any future time extensions are required two or more single units can be connected by the removal of party walls. Sites let on ground lease to firms building the larger factories are so laid out as to facilitate future extensions if these are required. Other sites are available for leasing to firms for the erection of smaller factories where a standard factory unit is not considered suitable.

In the new town at Harlow 160 acres of planned estate are being opened up and developed for industry. The corporation here is building standard factories of about 20,000 square feet for renting or for sale, subject to ground rents, and sectional factories for renting in units of about 2000 square feet. Each sectional factory can be used as a self-contained works unit or several bays can be combined to form one factory. In these sectional factories the production area of one bay, exclusive of ancillaries, is 1770 square feet.

Each standard factory has a production area of 13,824 square feet, which is designed to permit an expansion of 4608 square feet, if required. A two-storey office block, laid down at the front of each standard factory, has a floor space of 5060 square feet, which can be subdivided as required.

Amongst the firms which now occupy standard factory units at Crawley are Rediweld Ltd., Aerox Ltd., and the Vaughan Lift Engineering Company, Ltd. In the photograph we reproduce can be seen the entrance to a typical works.

Rediweld Ltd. specialises in the fabrication of thermoplastic materials, mainly for the chemical and chemical engineering industries. The work is of a varied nature, calling for an



CHASSIS ASSEMBLY LINES AT AUSTIN WORKS

STANDARD FACTORY AT CRAWLEY

open shop lay-out with movable benches which can be arranged to suit the work in hand. As can be seen from the accompanying photograph of the shop, the few machines used are arranged at one side, leaving the main floor space clear for bench work.

At this factory the gas welding method is largely used for the large-scale production of thermoplastic articles from rigid sheet and tube materials, such as polythene and unplasticised P.V.C. With an electrically or acetylene heated torch either nitrogen or compressed air is passed over the heater element to produce from the nozzle a stream of gas at a temperature well above the melting or softening point of the plastic material. This stream of gas is directed by the operator against the material and a filler rod of the same composition to form the required joints in building up a unit.

The Aerox factory is concerned mainly with the manufacture and assembly of complete filter and diffusion units incorporating "Porsilex" porous ceramic media elements made at the firm's ceramic division in Glasgow.

These filters have a wide range of application in industry, as they are suitable for any pressures of air, gas, or liquid up to 5000 lb per square inch and are quickly cleaned by reverse flow, whilst the filter media is virtually inert and very hygienic.

In the single-unit standard factory it has taken at Crawley the Vaughan Lift Engineering Company, Ltd., is making its full range of electric and manual lifts, hoists, blocks, cranes, &c. In this little works it has been necessary to adopt a fairly flexible shop lay-out owing to the fact that many types of hoists, &c., are made to special designs, in addition to the standard products of the firm. For this reason the production machines have been set down one side wall of the shop and the main area is left clear for the fabrication and assembly of large units.

Components for the smaller standard units are made in batches and assembled on benches which can be moved, when necessary, to provide space for work on large units. For block testing purposes an overhead girder is supported on stanchions down the centre of the shop, and hoists are tested on a structure at the rear of the building.

THERMOPLASTIC FABRICATION SHOP OF REDIWELD LTD.

Oil Refineries in 1951

FROM pre-war days there has been a spectacular rise in the world consumption of oil and this has caused a considerable changeover in the source of supplies. America has now become an importer of oil, so that Europe could no longer rely upon supplies from the United States and the Caribbean, but had to turn to Middle East sources, where production has been rapidly expanded to meet the increased demand. The greater flow of crude oil called for increased refining capacity so that during the post-war years a number of new refineries have come on stream. International economic forces, the shortage of hard currencies in Europe and many other diverse factors, including estimates of future demand and supply, influenced the pattern of development. The imperative need to restrict the dollar content of oil caused the companies to reverse the old policy of refining oil at the source of production and to embark on a new refinery building scheme, which is playing and will play even a greater role in the economic and industrial recovery, as new refineries are brought into operation. As a result of the scheme Great Britain now has a new major industry and the largest single project in the development programme was the refinery at Fawley, near Hythe, in Southampton Water, which was opened by Mr. C. R. Attlee, and described in THE ENGINEER on September 21st and 28th, 1951.

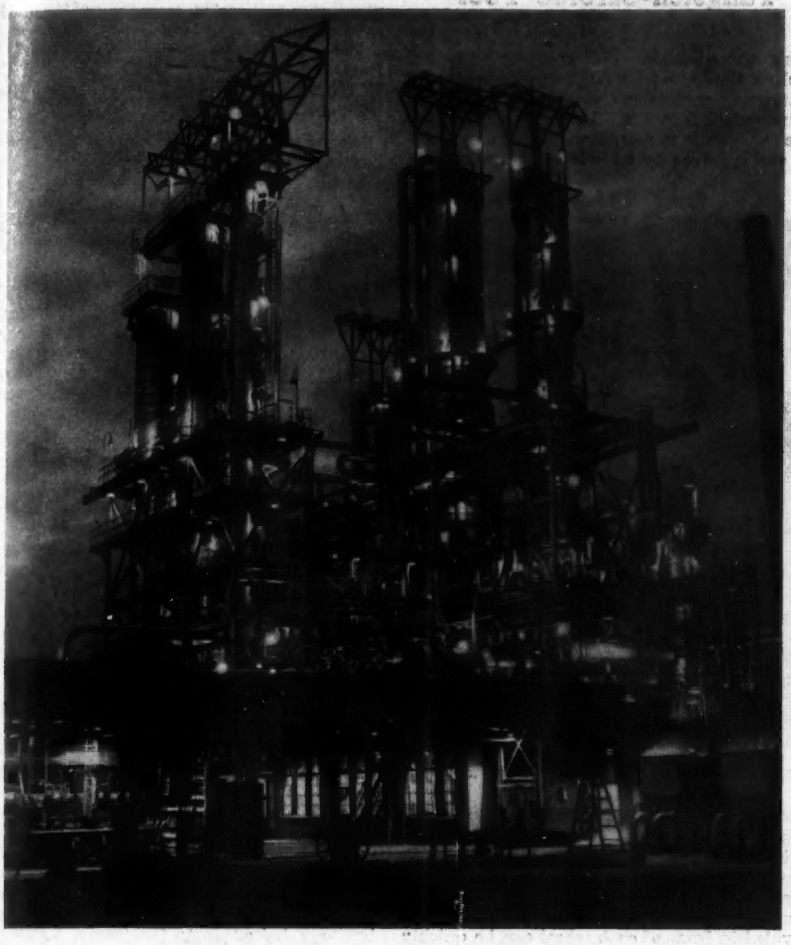
World consumption of oil has approximately doubled in the last ten years and the annual rate is now about 500,000,000 tons, while Middle East production of low dollar content oil, upon which depends the success of the European refinery expansion, increased nearly three-fold since the war. In this country the O.E.E.C. oil committee estimates that the new refineries will raise the throughput to more than 21,000,000 metric tons in 1952, an amount which is more than eight times the immediate post-war production level. Another effect of the expansion programme is the complete reversal of the relationship between the refined products and crude oil imported into Britain. After the war Britain imported more than four times as much refined products as crude and the oil committee estimated that in 1952 the imports of crude at 21,000,000 tons, would be more than ten times that of refined petroleum.

Built for the Esso Petroleum Company, Ltd., at a cost of £37,500,000, the new refinery at Fawley occupies a 450 acre site; work commenced in 1949 and the refinery came on stream in September last year, with the completion of phase one. When phase two is ready in 1953, the refinery, which is the largest in Europe, will produce nearly 6,500,000 tons of petroleum products annually, about 1,000,000 tons more than at present, including about 1,500,000 gallons of petrol per day, enough to satisfy one-third of Britain's requirements. Crude oil is brought by oil tankers, for the berthing of which a new marine terminal, having a jetty 3200ft in length and a 2000ft long approach, was built. The jetty can accommodate four tankers having a length between perpendiculars of 700ft and the ships are moored to tee-shaped breasting islands, each of which consists of two caissons 40ft in diameter and fitted with two heavy steel fenders.

The crude oil is pumped through pipes, carried on the approach and the pipe road, to floating roof storage tanks, from where it passes through the pipe still heater to distillation units. These consist of a single-stage atmospheric unit, which is 114ft in height by 21ft diameter, and a combination vacuum and atmospheric unit, the vacuum tower being 110ft high by 28ft diameter, and the fractionating tower 88ft high. To obtain more petrol than is provided by straight distillation a fluid catalytic cracking plant, illustrated on Plate 4, was built and the unit consists of a fractionating tower 130ft high by 20ft diameter, a reactor 35ft in diameter by 70ft high, a regenerator 55ft in diameter by 70ft high, and a catalyst storage hopper. Wet gas passes through the 113ft high debutaniser tower, where butane is removed from the motor spirit.

At Fawley there is installed various special treatment plants to improve the quality of the products. Middle East crude oil has a high sulphur content and a copper chloride sweetening unit removes organic sulphur compounds from the straight-run gasoline, while turbo-jet fuel and kerosene are similarly treated in a hypochlorite plant. A hydro-desulphurisation plant removes the sulphur content of tractor fuel and there is the Edeleanu plant, which is a sulphur dioxide extraction unit, where the sulphur content of kerosene is reduced. In the polymerisation unit, butylene gas is converted into a high octane liquid and, to produce lubricating oils, gas oil stock will be treated in four plants, which are under construction. These are a propane de-asphalting plant, a phenol extraction plant, a propane de-waxing unit and a clay contact and vacuum return unit. Another unit is the bitumen oxidising still and a major plant which is under construction is that for the production of sulphur. This sulphur recovery plant, which is planned to produce 12,000 tons annually, will be completed early in 1953.

The refinery expansion programme of the Shell Petroleum Company, Ltd., made further progress during the year and additional units were constructed and put into operation at both Stanlow and Shell Haven. A second distillation plant, illustrated in



STANLOW REFINERY DISTILLATION UNIT AT NIGHT

Plate 4, and in the accompanying photograph showing the plant operating at night, came on stream in June last year at the Stanlow refinery. Together with the first distillation unit, which commenced operating in 1949 and produces 1,000,000 tons per annum, it has raised the capacity of the refinery to over 3¾ million tons annually. A catalytic cracking plant is practically complete and will convert part of the heavier distillate oil to high quality gasoline and, with the polymerisation units, will enable the refinery to vary the output of different kinds of refined products to meet the market demands. Other refining plants provided petroleum gas for the manufacture of chemicals and liquefied petroleum gas for industrial and domestic use. To guard against any sensible rise in the temperature of the Manchester Ship Canal water, which is used for dissipating the heat from the refinery process plants, a large concrete cooling tower rising to a height of 340ft and having a capacity of 5,000,000 gallons per hour floated was constructed.

Further projects which are under construction are a sulphur recovery plant, designed to produce about 10,000 tons per annum from the hydrogen sulphide derived from the cracking of Middle East crudes, and an acid plant for the conversion of waste sulphuric acid sludge to fresh acid. The Anglo-Saxon Petroleum Company, Ltd., recently added to its fleet a number of tankers of 28,000 tons deadweight and to accommodate vessels of this size when used to supply Stanlow, the Manchester Ship Canal Company is constructing an oil dock at Eastham, a review of progress of which will be given in "Civil Engineering in 1951."

Since the first Shell Haven distillation plant was put into commission in 1950, two further units have been completed: a Doctor treating plant for the treatment of 1300 tons per day of straight-run gasoline and a reforming unit, which processes 1200 tons of naphtha or light gas oil daily. A feed preparation plant is still under construction and when complete will produce 2500 tons per day of bitumen feed stock for handling in the Shell Haven East Refinery. Shell Haven at the end of the year was refining at the rate of about 3,000,000 tons a year. The overall annual capacity of the Shell refineries at Stanlow, Shell Haven, Heysham and Ardrossan, in 1951, amounted to approximately 8¼ million tons.

During the year the Anglo-Iranian Oil Company greatly increased the capacity of the refineries at Llandarcy and Grangemouth, as a result of plant modification and the inclusion of new units. The new Kent refinery on the Isle of Grain, which the company has under construction, made considerable progress. Approximately 110 acres of low-lying marsh land was raised in level by pumping silt from barges through a pipe-line to the site. The crude oil storage tank farm was nearly completed by the end of the year. The 80,000 barrels per day crude oil distillation unit, seen in a photograph reproduced in Plate 4, with its associated banks of heat exchangers and other auxiliary plants for sweetening and blending processes, which forms Stage 1 of the refinery construction programme, reached an advanced stage. This section of the refinery is expected to come on stream in June this year, with an initial output rate of 2,000,000 tons per annum.

By August last year the annual capacity of the Llandarcy refinery reached 4,000,000 tons and this was achieved by running distillation units at a greatly increased rating and by converting other plant to act as distillation units. The first stage of the Grangemouth refinery expansion programme, of which a unit is illustrated on Plate 4, was completed early last year and raised the capacity from 600,000 tons to 1,800,000 tons per annum; our illustration shows the phosphoric acid unit. This latter figure was raised to 2¼ million tons by means similar to those adopted at Llandarcy. The second stage, which includes a catalytic cracking unit, a vacuum distillation unit and a catalytic polymerisation plant, made progress during 1951 and will be put into commission in the first half of this year. The 60 mile long, 12in diameter

GRANGEMOUTH REFINERY PHOSPHORIC ACID UNIT

pipe-line, which transports the crude oil from the storage tanks on the West Coast of Scotland to Grangemouth, and the marine terminal at Finnart on Loch Long, were completed and the first tanker off-loaded at Finnart in February, 1951. A general description of the lay-out and construction of the extension to the Scottish Oils, Ltd., refinery at Grangemouth was given in a paper entitled: "The Construction of a Modern Oil Refinery," which was read by Messrs. W. Y. Robb and W. M. Greenhorn before the Institution of Engineers and Shipbuilders in Scotland early last year. The refinery at Pumpherston continued to refine Scottish shale oil and crude from the Nottinghamshire and Lancashire fields.

At Coryton, on the Essex bank of the Thames, Powell Duffryn, Ltd., and the Vacuum Oil Company, Ltd., are building a refinery which is designed mainly for the manufacture of lubricating stock oils. The initial work, which consisted of levelling the site, driving piles and preparing foundations, made considerable progress during the year and the above-ground work went forward in the construction of the storage tank farm and the erection of equipment for process units.

A refinery planned by the Caltex group, to be erected on the eastern shore of Southampton Water, between Southampton and Portsmouth, was approved in principle by the Government. At the Partington plant of Manchester Oil Refinery, Ltd., work was started on the building of a new 3500 barrels per day atmospheric distillation unit, which would raise the annual production rate from 115,000 tons to 150,000 tons. The new unit is designed to work in conjunction with the existing vacuum distillation unit and will enable the refinery to use Middle East crude oil. During the year another extension to the Petrochemicals Plant at Partington, which produces petroleum chemicals by the "Catarole" process, was put into full-scale production. The new plant, all the buildings of which are sealed and air-conditioned, covers an area of nearly five acres and can produce over 5000 tons per annum of polystyrene from a monomeric styrene base.

In September of last year the new vertical lubricants plant of Shell Mex and B.P., Ltd., was opened at Barton, Manchester, and adjoining the Grangemouth refinery two chemical plants approached completion. The factory, being built for the British Petroleum Chemicals, Ltd., will produce, among other products, industrial alcohol and that of Forth Chemicals, Ltd., will produce monomeric styrene.

The catalytic cracking units, now in operation at a number of refineries, require a quantity of catalyst and this will be supplied by a catalyst plant, which was built at Warrington at the works of Joseph Crosfield and Sons, Ltd., and completed at the end of last year.

Another oil product, which is closely linked with the need to reduce dollar expenditure, is carbon black and, in October last year, Philblack, Ltd., opened its new factory at Avonmouth. The plant, which uses a special process oil, has been designed to produce approximately 50,000,000 lb of carbon black per annum. It was fully described in THE ENGINEER, October 26, 1951.

LLOYD'S REGISTER NEW CONSTRUCTION.—During 1951 Lloyd's Register of Shipping approved plans for the construction of 750 ships, totalling more than 4,000,000 tons gross, a figure which has only been exceeded in 1918. Of the total, 408 ships of 2,236,000 tons are to be built in the United Kingdom and 342 ships of 1,792,000 tons abroad, and 57 per cent of the total tonnage are oil tankers.

Tungsten-Carbide Tool Grinding Machine

THE three-headed tool grinding machine, which is illustrated below, has been designed for tungsten carbide tool sharpening by Walter Kraumendahl G.m.b.H. In this machine each wheel spindle is mounted on large roller bearings and is driven by an independent reversible motor. A copious supply of coolant is pumped during the grinding operation from large settling tanks in the machine base. At each grinding station there is plenty of room for an operator and, if necessary, all three heads can be used simultaneously. A slotted work table provided in front of each wheel can be quickly set and locked by means of two levers at the required angle to facilitate the grinding of tools A similar machine, but with four spindles, is also being made.

TRIPLE HEADED TOOL GRINDER

A second type of tool grinding machine made by this firm is specially designed for the grinding of chip breaker grooves in turning tools. In this machine the tool is clamped on to an adjustable tilting table, which can be swivelled in two directions to suit the required groove angle. To facilitate the positioning of a tool whilst it is being clamped on the table an adjustable setting gauge is provided on the machine column adjacent to the grinding wheel. During the grinding operation the main table of the machine is reciprocated by a long lever handle.

These machines are distributed in this country by the Rockwell Machine Tool Company, Ltd., of Welsh Harp, Edgware Road, London, N.W.2.

A Haulage and Recovery Vehicle

WE have received from A.C.V. Sales, Ltd., of Southall, Middx, particulars of a "Mammoth Major" six-wheeled chassis which it recently supplied to a Brazilian firm for the dual purpose of semi-trailer haulage and vehicle recovery. The arrangement of the vehicle can be seen in the photograph we reproduce below.

The chassis has a 14ft 6in wheel base and is fitted with an 11·3 litre oil engine of 150 b.h.p., drive being taken through a single plate clutch and five-speed and reverse constant mesh gearbox. Final drive to the road wheels is by a double drive, spiral bevel and double helical gears giving a reduction of 7·9 to 1.

Fully articulated rear suspension allows the vehicle to be driven over rough, uneven surfaces with the maximum adhesion of the road wheels. As no third differential is fitted, the machine is particularly well suited for these "off the road" conditions.

The gin poles of the crane are tapered at each end, and are erected above the end of the chassis frame. The lower ends of these poles are located by bolts in substantial brackets attached to the frame, whilst the upper ends are held together by a common bracket or crown block, which also carries the anchorage for the pulley and the tie chains. The poles are strengthened by angle iron welded over their parallel length. To the iron are welded brackets to carry shackles for securing bracing chains, both sets of which are linked to the chassis by brackets bolted on to the frame. This crane was supplied by M. O. Harper, Ltd., of Guildford.

The cable from the winch is taken via a free snatch block to a second block suspended from the crown block. The winch, which is fitted with an automatic brake, is capable of exerting a pull of 25,000 lb and is driven from the power take-off through a reversing gearbox.

A rack mounted behind the cab and above the winch is used for carrying the bracing chains, &c., and for stowing the gin poles and snatch blocks when the vehicle is used for hauling a semi-trailer.

A HAULAGE AND RECOVERY VEHICLE

Industrial and Labour Notes

Coal Production

Revised figures issued at the end of last week show that Great Britain's total coal output for 1951 was 222,181,400 tons, of which 211,195,600 tons came from the deep mines and 10,985,800 tons from opencast workings. In 1950 the total output was 216,308,600 tons. Coal imports last year amounted to 1,220,700 tons.

On December 29th last the total number of wage-earners on colliery books was 697,900, of whom 286,800 were face workers. These figures show that the small increase in colliery manpower, which has been apparent over the last two or three months, continues, although the number on colliery books as the year ended was below the weekly average of 698,600 over the fifty-two weeks of last year. Shifts worked per wage-earner last year averaged 4·84 a week, compared with 4·75 in 1950, and the output per manshift at the face averaged 3·18 tons in 1951, compared with 3·11 tons in the preceding year.

Inland coal consumption in fifty-one completed weeks of last year was 204,231,000 tons, against 198,268,000 tons in the comparable period of 1950. In the same period last year exports and bunkers took up 11,497,000 tons, compared with 16,902,000 tons in 1950. The total distributed stocks of coal on December 29th last were 16,256,000 tons. On the same date of 1950 stocks were 12,423,000 tons.

Railway Shopmen's Wages

At the beginning of this week representatives of the Railway Executive and of engineering and railway unions had a discussion with Sir Robert Gould, the principal negotiating officer of the Ministry of Labour, concerning the deadlock which has been reached over a pay claim for railway shopmen. The unions put forward, some months ago, a claim for a "substantial increase," in response to which the Railway Executive made an offer of approximately 8 per cent, which was the amount of the increase given in November to other grades of railwaymen. It has been suggested that, in the case of the railway shopmen, this offer would have meant increases of 8s. a week for unskilled workers and 9s. 7d. a week for craftsmen. The union side of the Railway Shopmen's National Council argued that the offer did not compare favourably with the general increase of 11s. a week recently awarded in the engineering industries. The unions then notified the Minister of Labour of the dispute.

Wages Policy

In the course of an article published in the January number of *Lloyds Bank Review*, Professor E. H. Phelps Brown and Mr. B. C. Roberts, of the London School of Economics, have commented on wages policy in Great Britain. They suggest that it is a remarkable feature of the British economy during and since the second world war that amid controls of many kinds there has been virtually no control of wages. Almost all the main wage changes, the article says, have continued to be made by agreements freely reached between employers and employed.

But, the authors continue, the lack of central wage control has been held to constitute a serious handicap to our economy in meeting the needs of the hour. Some regard it as partly responsible for the great rise of costs and prices. In eleven years, the article says, there has been a general doubling of money wage rates. It goes on: "If we take an index of those rates as standing at 100 when war began, it rose by about ten points a year steadily through 1946, and by about eight points a year on the average of the five years since. Granted that this is the outcome of inflationary pressure, much of which arose independently of wage increases, have not these maintained that pressure and raised it? Suppose the inflationary gap is closed, and the demand for labour comes to match the supply at a high level of employment; even though there is now no inflationary pressure, it can still be contended that the low level of unemployment must of itself give the trade unions so great a bargaining power that they will be able to enforce recurrent rounds of wage rises. Thus it is argued that some central control of wages is essential, as a check to inflation in recent conditions, or even as a permanent part of our equipment for keeping the labour market balanced at a high level of employment."

The article adds that the case for central wage control as a necessary concomitant of full employment is likely to rest on an implicit appeal to the experience of recent years. But it goes on to say "after all the changing scenes through which we have passed year by year, we see now on looking back that we have been living through an almost continuous inflation, in which the cost of living and industrial wage earnings have alike risen by a third or more in six years. Let it be agreed at once that so long as inflationary pressure persists, wage rises will come about perpetually unless there is concerted restraint."

British Manufacturing Industry's Capital Expenditure

Early last year, an inquiry was undertaken by the Board of Trade, Ministry of Supply and other Government departments into the level of capital expenditure by manufacturing industry in Great Britain in the years 1949 and 1950. It was the second inquiry of its kind, the first having been undertaken in 1950 to obtain information on capital expenditure in the years 1948 and 1949.

The inquiry covered—on a sample basis—all establishments in Great Britain engaged in manufacturing, with the exception of establishments employing ten or less people; British Transport Commission establishments; Royal Ordnance Factories, Government-owned factories managed by private firms on an agency basis, and Service Departments' establishments. The questionnaire asked for a return of expenditure charged to capital account in each of the years 1949 and 1950 under the headings of plant and machinery, vehicles and vessels, and buildings and other constructional work. Expenditure on second-hand plant, machinery, vehicles and vessels was distinguished from expenditure on new items, but the purchase of existing buildings, land and leases was excluded.

The Board of Trade has now summarised the information obtained by the inquiry. About 4300 questionnaires were sent out, and of that number 3950, or 92 per cent, were completed and returned. The results of last year's inquiry and of the preceding one show that capital expenditure was £383,000,000 in 1948, £423,000,000 in 1949, and £496,000,000 in 1950. Of those totals, plant and machinery represented £256,000,000, £284,000,000 and £337,000,000 respectively in the three years, and new buildings and works accounted for £92,000,000, £100,000,000 and £116,000,000 respectively. The analysis of capital expenditure between the various industry groups indicated substantial increases in the level of capital expenditure in some industries, notably in mineral oil refining, other chemical and allied trades, and in metal manufacturing (the principal constituent of which is the iron and steel industry). For the purposes of the inquiry, the industries were grouped according to the standard industrial classification, and in the group which includes "engineering, shipbuilding and electrical goods," capital expenditure totalled £61,000,000 in each of the years 1948 and 1949, and £66,000,000 in 1950.

Index of Industrial Production

The index number of industrial production (1946=100), which is prepared by the Central Statistical Office of the Treasury, has been estimated provisionally at 151 for all industries for October last, compared with 146 for September. The figures for the corresponding months of 1950 were 152 for October and 143 for September. Taking the manufacturing industries only, the index number for October last has been calculated as 156, compared with 152 for September. But for October, 1950, the figure was 158.

Exports in 1952

In the January issue of its *Review*, the Federation of British Industries has commented on "the twin task of carrying out a rearmament programme, the burden of which is bound to be greater this year than last, and of increasing exports still further." It says that the need for greater exports has become such a familiar cry in the last five years that "we are in danger of becoming deaf to it." With this country in deficit all round the world, however, the need is real and everything possible must be done to meet it.

The obstacles are formidable, the F.B.I. says, as at home the claims of rearmament are competing with those of exports for an inadequate supply of materials and manpower, especially skilled engineering manpower. In addition, there is the task of cutting down the competing claims of the so-called "less essential" requirements of the home market. Overseas also the difficulties are growing. The seller's market for capital goods persists, but in many lines of consumer goods the buyer is coming into his own again and is becoming more "choosey." Attempts by other countries to curb inflation inside their borders have reduced consumer spending with the result that purchases of some British goods are falling off. While world consumption of many materials, especially coal, steel and most of the non-ferrous metals is still increasing, in other commodities it is, for the time being at least, declining. At the same time as consumer resistance is growing, increasing foreign competition in overseas markets is having to be met.

In meeting that competition, the F.B.I. emphasises, the prices of British exports will be one, and possibly the most important, of the keys to success or failure in 1952. The "shot in the arm" which devaluation gave to our exports two years ago has now largely worked itself out. Basic costs—particularly coal, transport and wages—are still rising and so, therefore, are prices. But further increases must be stopped if this country is to hold its competitive position in world markets, and, again, that depends very largely upon the Government's success in checking inflation.

The British Export Trade Research Organisation

The council of the British Export Trade Research Organisation has decided to recommend the voluntary winding-up of the organisation. B.E.T.R.O.—a non-profit-making organisation—was founded in 1945 by a group of industrialists to carry out market research into overseas markets for British goods. In 1947 Parliament voted it a subsidy of £150,000, to be taken up over five years; but, chiefly through collaboration with the Federation of British Industries, only £130,000 of that subsidy was actually taken up.

In announcing the council's decision, Mr. Leslie Gamage, the chairman, said that although B.E.T.R.O. had received loyal support from its members, as well as help from the Federation of British Industries, it had not obtained sufficient work to enable it to pay its way. He suggested that the organisation had been "ahead of its time" as the post-war seller's market made British firms slow to grasp the importance of market research, while the rearmament programme had created fresh difficulties. Nevertheless, in the face of growing competition from other countries, Britain would suffer heavy setbacks if she did not carry out more thorough and systematic research in export markets. Mr. Gamage added that in its seven years B.E.T.R.O. had completed 3000 assignments, including 300 market surveys, in eighty-two countries.

Notes and Memoranda

Rail and Road

EXPRESS COAL TRAINS.—We are informed by British Railways that it has fitted a hundred standard 16-ton coal wagons with vacuum brakes in order to carry out comprehensive brake trials. In these trials a loaded coal train, which will leave Toton Sidings, Derbyshire, on alternate Sundays from January 6, 1952, for London (Brent), will travel at express speeds and convey up to 1000 tons of coal. These trials, it is stated, are the preliminary steps in an investigation into the possibility of fitting all freight vehicles with automatic brakes and to enable them to run at much higher speeds.

Miscellanea

THE LATE MR. R. F. D. BRUCE.—We have learned with regret of the death, after a prolonged illness, of Mr. R. F. D. Bruce, of James Neill and Co. (Sheffield), Ltd. Mr. Bruce was a member of the council of the Machine Tool Trades Association, and also of the allied trades section of the Association, and was well known in tool trade circles throughout the country.

BRITISH ELECTRICAL POWER CONVENTION.—The council of the British Electrical Power Convention has decided, in the interests of economy, that the convention to be held at Bournemouth in June, 1952, shall be curtailed. Accordingly, the convention will open on the morning of Monday, June 16th, and will end at noon on Wednesday, June 18th. Within this period the programme, as already determined, will be undertaken, but the usual official electrical exhibition will not be held.

COPPER AND ZINC.—Manufacturers of goods in which the use of copper, zinc and their alloys was banned by a Ministry of Supply Order in November, are to have a further twenty-day period in which to finish partly made goods containing the metals. The original order (The Copper and Zinc Prohibited Uses (Ministry of Supply) (No. 2) Order, 1951) gave them until February 1, 1952, to use up stocks of fabricated or partly processed zinc and copper. A new Order is to be made extending this period until February 20th and making amendments to the list of prohibited articles.

AN A.S.L.I.B. CONSULTANCY SERVICE.—To further its work of assisting the establishment and development of information services and special libraries, A.S.L.I.B. announces that it has now set up a consultancy service. This service will provide advice in connection with the economical running of existing, or the planning and inauguration of new, information services or special libraries. The service will be backed by the resources of A.S.L.I.B. headquarters and amongst other things will give advice on the lay-out and use of premises, equipment, staffing, book selection, loan systems, circulation of information, records, &c.

APPRENTICESHIP SCHEME.—The Lockheed Hydraulic Brake Company, Ltd., of Leamington Spa, has just issued an illustrated brochure, which gives details of the new apprenticeship scheme adopted by the company. The broad overall outlines of the scheme are mentioned and two courses are open to entrants, namely; the General Apprenticeship Course and the Student Apprenticeship Course. There are three training classes in the general course, which begins at the age of sixteen years, and two classes in the student course, where the commencing age is eighteen years. For both courses a diagram indicates the training arrangements and also the resulting opportunities.

PETROLEUM CHEMICAL PLANT CONSTRUCTION.—Petrocarbon, Ltd., of Partington, Manchester, has issued a booklet containing reprints of three papers, which deal with the technical problems in building a petroleum chemical plant. The first paper, entitled "Some Engineering Aspects of Building a Plant for the Production of Chemical from Petroleum," was read by Mr. H. E. Charlton, before the Manchester Association of Engineers, on February 24, 1950. "The Fuel, Heat and Power Aspects of the Petroleum-Chemicals Plant for Petrochemicals, Ltd., Partington," was the title of a paper given before the Institute of Fuel on April 26, 1950, by Messrs. E. Bonwitt and H. E. Charlton and the third paper, entitled "Chemical Engineering Aspects as Applied to the Building of a Petroleum-Chemicals Plant," was delivered on April 28, 1951, before the North-Western branch of the Institution of Chemical Engineers. The booklet includes several photographs of the plant and concludes with a flow chart, which illustrates the processes through which the gases and liquids from the "Catarole" cracking plant pass and link particular products with individual plants.

ECONOMIC ASPECTS OF THE OIL INDUSTRY.—A supplement to *Oil*, the journal of the Manchester Oil Refineries group of companies, has been issued in the form of a paper by Mr. G. Tugendhat and Miss C. Mackintosh, entitled "Some Economic Aspects of the Oil Industry in 1951." The paper examines the economic foundations of the oil industry in the light of present and future economic trends and it is noted that the three main factors are Middle East troubles, the completion of the European refinery programme and the importance of oil to national defence. Conditions under which the oil industry has developed are examined, together with the effect of restrictions, placed to-day, upon the earlier condition of economic freedom. National oil policies are discussed and the possible repercussions of the "share and share alike" motive. Tables analyse the various aspects of the industry, such as production, taxation, government income and capital investment.

Contracts

DURING December, 1951, the British Electricity Authority placed contracts for equipment for power stations, transforming stations and transmission lines amounting in the aggregate to £37,297,120. The principal contracts include: Brunswick Wharf power station—132kV, 2500MVA switchgear (British Thomson-Houston Company, Ltd.); Hackney power station—two 300k-lb per hour boilers (Simon Carves, Ltd.); Cowes power station—two 12·5MW turbo-alternators, condensing and feed heating plant and associated equipment (Brush Electrical Engineering Company, Ltd.); Portishead "B" power station, Bristol—six 300k-lb per hour boilers (Mitchell Engineering, Ltd.), and one 60MW turbo-alternator (Metropolitan-Vickers Electrical Company, Ltd.); Goldington power station, Bedford—two 300k-lb per hour boilers (Clarke, Chapman and Co.; Ltd.); Castle Donington power station, Derby—three 100MW turbo-generators (Metropolitan-Vickers Electrical Company, Ltd.); Drakelow power station, Burton-on-Trent—two 60MW turbo-alternators, condensing and feed heating plant (English Electric Company, Ltd.), two 515k-lb per hour boilers (International Combustion, Ltd.), and high pressure steam and feed piping (Aiton and Co., Ltd.); Northampton power station—two 150k-lb per hour boilers (Simon Carves, Ltd.); Meaford "B" power station, Staffs.—three 515k-lb per hour boilers (Babcock and Wilcox, Ltd.), condensing and feed heating plant (British Thomson-Houston Company, Ltd., and Hick, Hargreaves and Co., Ltd.); Stourport "B" power station—one 515k-lb per hour boiler (International Combustion, Ltd.); Uskmouth power station, Newport—twelve 360k-lb per hour boilers (Babcock and Wilcox, Ltd.), auxiliary switchgear and transformers (General Electric Company); Connah's Quay power station, Flint—two cooling towers and circulating water conduits (Yorkshire Hennebique Contracting Company, Ltd.); Ince power station, Ellesmere Port—condensing and feed heating plant (Hick Hargreaves and Co., Ltd.); Doncaster power station—two 30MW turbo-generators, condensing and feed heating plant (Brush Electrical Engineering Company, Ltd.); Blackburn power station—one 40MW turbo-alternator, condensing, feed heating and evaporating plant (English Electric Company, Ltd.); Keadby power station, Scunthorpe—one 550k-lb per hour boiler (Stirling Boiler Company, Ltd.); Wakefield power station, Yorks—three 60MW turbo-alternators (English Electric Company, Ltd.), condensing plant (Worthington-Simpson, Ltd.); North Tees power station, Middlesbrough—one 360k-lb per hour boiler (Babcock and Wilcox, Ltd.); Carrington power station, Manchester—one 60MW turbo-alternator, condensing, feed heating and central evaporating plant (Metropolitan-Vickers Electrical Company, Ltd.); Chadderton power station, Oldham—two 360k-lb per hour boilers (Simon Carves, Ltd.); Fleetwood power station—two 300k-lb per hour boilers (Simon Carves, Ltd.); Hartshead power station, Stalybridge—one 150k-lb per hour boiler (Babcock and Wilcox, Ltd.); Portobello power station, Edinburgh—one 60MW turbo-alternator (Richardsons, Westgarth and Co., Ltd.), one 540k-lb per hour boiler (International Combustion, Ltd.), main steam and feed pipework and valves (Aiton and Co., Ltd.), civil engineering work in foundations (W. J. and R. Watson, Ltd.); West Melton substation, Yorks—132kV, 3500MVA switchgear (British Thomson-Houston Company, Ltd.); Stella South power station, Newcastle upon Tyne—one 550k-lb per hour boiler (Clarke, Chapman and Co., Ltd.), and Roosecote power station—four 300k-lb per hour boilers (Yarrow and Co., Ltd.).

Personal and Business

AIR COMMODORE W. WYNTER-MORGAN has joined the Armstrong Whitworth Aircraft Company, Ltd.

DUNLOP, Ltd., announces the retirement of Mr. P. C. A. Welsh, regional manager in Northern Ireland.

MR. P. R. SCUTT, formerly director of production, Tecalemit, Ltd., has been appointed director and general manager.

SIR CUTHBERT CLEGG and Mr. George Hardman have been appointed directors of Textile Machinery Makers, Ltd., Oldham.

MR. P. D. IRONS, for seven years the secretary of Saunders-Roe, Ltd., has been elected to the board of directors of the company.

MR. W. T. W. BALLANTYNE, formerly S.B.A.C. representative in South America, has joined Armstrong Siddeley Motors, Ltd., as a liaison officer.

MR. A. A. MIDDLETON, B.Sc., A.M.I.C.E., has been taken into partnership by Sir M. MacDonald and Partners, 72, Victoria Street, London, S.W.1.

MR. E. W. MARVILL has been appointed general works superintendent, and Mr. H. B. Harris, production manager, of F. Perkins, Ltd., Peterborough.

MR. J. SIDNEY HAMPTON, a director of Davy and United Roll Foundry, Ltd., Billingham, Co. Durham, has been appointed to the additional post of general manager.

MR. J. K. INGRAM and Mr. W. J. Chadder have been appointed directors of the Woodall-Duckham Vertical Retort and Oven Construction Company (1920), Ltd., 63–77, Brompton Road, London, S.W.3.

THE DEPARTMENT OF SCIENTIFIC AND INDUSTRIAL RESEARCH states that the Technical Information and Documents Unit has moved to Cunard Building, 15, Regent Street, London, S.W.1 (telephone, Whitehall 9788).

KERBY'S (GREAT BRITAIN), Ltd., Warton Road, Stratford, E.15, announces the retirement of Mr. W. Hart from the position of managing director. He will continue to serve on the board. Mr. W. Norman Hart has been appointed managing director.

THE Board of the Fairey Aviation Company, Ltd., announces that Mr. L. Massey Hilton, D.F.C., A.F.C., A.F.R.Ae.S., has been appointed to be an additional Assistant Managing Director of the company, with effect from December 12, 1951.

GEORGE SALTER AND CO., Ltd., West Bromwich, states that Mr. G. A. Adams has been appointed sales manager of the spring division. Mr. W. N. T. Bearder has succeeded Mr. Adams as Coventry and East Midlands area manager at Warwick Row, Coventry.

THE DOCKS AND INLAND WATERWAYS EXECUTIVE announces the retirement of Mr. W. Mackenzie, chief engineer for docks, Humber Ports, Middlesbrough and Hartlepools. He will continue in the service of the Executive in an advisory capacity as engineer (general duties).

MCKECHNIE BROTHERS, Ltd., Ladywood, Birmingham, announces the retirement from the chairmanship of Mr. John Rae. He will continue to serve as a director. Mr. J. D. McKechnie, formerly managing director, has been appointed chairman of the company.

IMPERIAL CHEMICAL INDUSTRIES, Ltd., announces the retirement of Mr. A. M. Kempson from the post of joint managing director of the Metals Division. Dr. M. Cook has succeeded him, and Mr. St. J. Elstub and Mr. G. A. D. Smith have been appointed to the board of the division.

THE BRITISH ELECTRICITY AUTHORITY states that Mr. W. A. Gallon, M.I.E.E., chief engineer of the South-Eastern Electricity Board, has been appointed controller of the Merseyside and North Wales Generation Division. Mr. H. B. Campbell, A.M.I.Mech.E., F.Inst.F., superintendent of the Cliff Quay power station, Ipswich, has been appointed generation engineer (construction) in the Eastern Division.

THE HAWKER SIDDELEY GROUP has announced the following staff changes at the Avro Canada company: Mr. Edgar H. Atkin, formerly chief engineer, takes the newly-created position of technical director; Mr. James C. Floyd, formerly works manager, becomes chief engineer, and Mr. Dennis E. Wiseman, formerly production planning manager, becomes works manager. Mr. Fred T. Smye, a director of the company, has been selected for the newly-created position of general manager.

British Patent Specifications

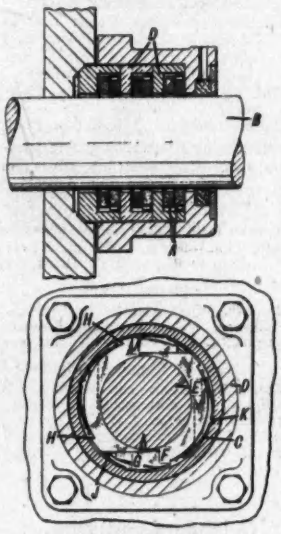
When an invention is communicated from abroad the name and address of the communicator are printed in italics. When an abridgment is not illustrated the specification is without drawings. The date first given is the date of application; the second date, at the end of the abridgment, is the date of publication of the complete specification.

Copies of specifications may be obtained at the Patent Office Sales Branch, 15, Southampton Buildings, Chancery Lane, W.C.2, 2s. each.

SHAFT PACKINGS AND GUIDES

660,045. January 28, 1949.—STUFFING-BOXES FOR RECIPROCATING RODS, Ronald Trist and Co., Ltd., Bath Road, Slough; and Charles William Clarke, of Clare Cottage, Heather, Leicestershire.

As shown in the drawings, there are two pairs of segments *A* lying with their joints in staggered relationship. Each segment is pressed against the piston-rod *B* by a leaf spring *C*, which also bears on the inner cylindrical surface of the retaining ring *D*. The inner boundary of each segment consists of a part-circle *E*, a short step *F* and a straight edge *G*. The outer boundary includes two steps *H* and a



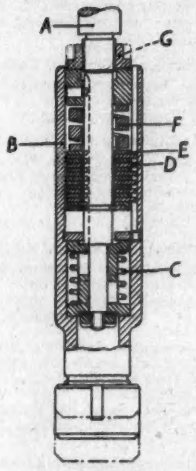
No. 660,045

straight edge *J*. The straight edges on the segments engage as shown, and as the part-circular faces and the rod wear away the segments are free to move radially together under the action of the springs. There is space to allow this movement, and leakage is prevented by the staggering of the joints. The centre of each leaf spring has a small projection *K*, which enters a depression in the form of an axial groove in the retaining ring. The ends of the leaf spring which bear on the segment also lie close to the steps and prevent rotation of the segments and disturbance of the staggered relationship. Alternative designs are also shown in the specification.—*October* 31, 1951.

WORKSHOP TOOLS AND APPLIANCES

663,102. April 1, 1949.—CHUCKS FOR HOLDING SCREWCUTTING TOOLS, Motor Car Works, National Corporation, Jungmannova 29, Prague II, Czechoslovakia; and Josef Hudik, of Cejetice 130, Mlada Boleslav, Czechoslovakia.

The invention relates to chucks for holding screw-cutting tools, such as taps or chasers, and is intended to provide an improved design particularly for use on multiple-spindle machine tools. It enables screw threads of different pitch to be cut while the rates of feed are maintained constant, and it incorporates means for interrupting the rotary motion of the tool when the cutting resistance exceeds a predetermined maximum value. As the drawing shows, the chuck consists of a spindle *A* and an outer body *B*. It is provided with a device for axially spring cushioning the chuck body with respect to the spindle and a friction coupling is interposed between the spindle and the chuck body. The axial spring cushioning of the body is ensured in both directions by a single helical spring *C* interposed between the flanges of a double-ended guide bush, which, together with a top bush, serves for guiding and supporting the body on the spindle. The friction coupling for transferring the rotary movement from the spindle to the chuck body is in the form of a disc clutch, which permits relative axial movement of the main portions of the chuck. The outer discs *D* of the clutch are engaged in grooves formed in the chuck body and the inner discs *E* in grooves in the spindle. The clutch discs are pressed against each other by a helical spring *F*, the tension of which is adjustable by a nut *G*. The maximum torque transmitted by the clutch, and hence the point at which the clutch begins to slip, can be regulated by adjusting the nut *G*. When cutting screw threads of a pitch other than that which corresponds to the rate of feed of the spindle, the axial spring cushioning of the chuck body comes into operation, allowing it to be axially displaced with respect to the spindle within predetermined limits. When cutting screw threads of a pitch greater than the rate of spindle feed, the chuck body is drawn by the tap more speedily into the bore in which the thread is being cut, the top part



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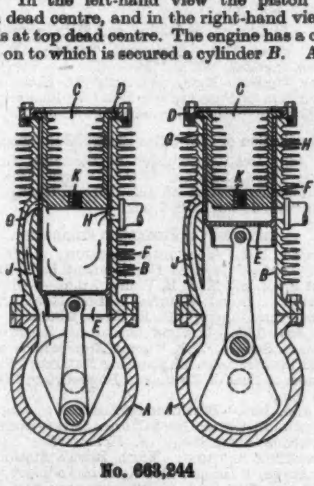
of the guide bush being carried along with it and the spring *C* being compressed. In cutting threads of a pitch smaller than the rate of spindle feed, however, the chuck body moves upward on the spindle and again compresses the spring. When the tap abuts against the bottom of a blind hole or when the cutting resistance exceeds the maximum torque which the clutch is capable of transmitting, then the clutch can slip, thereby bringing the tool automatically to rest. Any further feed motion of the spindle merely causes a compression of the spring.—*December* 19, 1951.

INTERNAL COMBUSTION ENGINES

663,244. April 16, 1949.—THE COOLING OF INTERNAL COMBUSTION ENGINES AND PISTON AND CYLINDER CONSTRUCTION, Algernon Fletcher, "The Haven," Glaziers Lane (formerly Station Road), Normandy, near Guildford, Surrey.

The drawings show side sectional elevations of the invention applied to a single-cylinder two-stroke engine. In the left-hand view the piston is at bottom dead centre, and in the right-hand view the piston is at top dead centre. The engine has a crank-case *A*, on to which is secured a cylinder *B*. A junk



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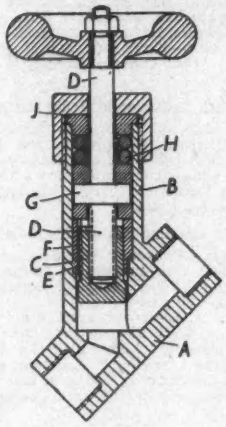
head *C* rests on the top of the cylinder, and a junk head retaining ring allows limited relative movement between the head and the cylinder in a clearance *D* formed between the ring and the cylinder. A piston *E* has a tubular portion *F*, which has a fuel transfer port *G* and an exhaust port *H* corresponding to transfer and exhaust ports of the cylinder, these ports being near the top of the piston. The portion *F* forms a sliding gas-tight seal with the junk head. Thus a combustion chamber is formed within the confines of *F* in which the fuel is compressed and burnt. The atomised fuel is drawn into the crank case in the usual manner by the ascending piston and is compressed within the crank case by the descending piston, the fuel being conveyed via the transfer passage *J* to the piston chamber *F* by means of transfer port *G*. The fuel is directed downwards by a deflector moulded in the junk head. The junk head also has a bore *K*, into which any suitable means of ignition, such as a sparking plug, may be screwed.—*December* 19, 1951.

VALVES

663,320. July 5, 1949.—PLASTIC CUT-OFF VALVES, Karl Wernert, Weissenburger Strasse 2A, Mulheim/Ruhr, Germany.

The invention concerns a design of cut-off valve made of synthetic material, such as hardenable phenol aldehyde resins or vinyl and styrol resins. The drawing shows that the valve housing *A* and



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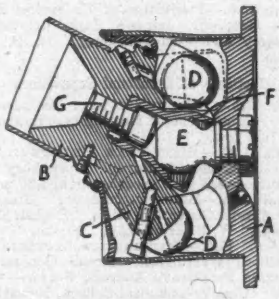
the cylindrical branch piece *B* are integral. A valve head *C* is screwed on to a spindle *D* and is axially displaceable in a sleeve *E*. A key portion *F* on the valve head engages in a groove in the sleeve and secures the head against rotation. The valve spindle *D* has a projection *G* which lies between washers. Above the upper washer rubber sealing rings *H* are provided. Rotation of the sleeve is prevented by means of a projection engaging in a recess of the sleeve. A pressure piece *J* in the branch acts on the rubber rings and is held against the rings by a screw cap which forms a guide for the spindle.—*December* 19, 1951.

POWER TRANSMISSION

662,744. October 19, 1948.—UNIVERSAL JOINT, The Gear Grinding Machine Company, Hamtramck, Michigan, U.S.A. (*Assignees of Fred Frank Miller, jun., of* 3492, *Kipling, Berkley, Michigan, U.S.A.*).

The construction of the universal joint comprises a pair of members *A* and *B* connected, respectively, to shafts or other rotating parts. They are provided with axially extending interspaced lugs *C* having torque transmitting balls *D* between them. Assuming that the two members move angularly with respect to each other about a fixed



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intersecting point in the axis, the balls are maintained always in a plane which bisects the angle between these axes and thus torque is transmitted at constant velocity. It is essential to maintain the members *A* and *B* in fixed relation to this point of intersection of their axes. This is effected by a tie connection which comprises a ball member *E* connected to the member *A*. A spherical socket *F* for receiving the ball, has an annular bearing retaining member secured to the socket by a snap ring. The socket *F* has a shank engaging a corresponding recess in the member *B* and secured to it by a bolt *G*. The parts are so located that the centre of the ball is the fixed centre about which the shaft members oscillate in the operation of the joint.—*December* 12, 1951.

Forthcoming Engagements

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of their insertion, the necessary information should reach this office on, or before, the morning of the Monday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

Association of Supervising Electrical Engineers

Mon., Jan. 14th.—CENTRAL LONDON BRANCH: St. Ermin's Hotel, Caxton Street, London, S.W.1, "Aluminium Sheathed Cables," F. M. Hollingsworth, 7 p.m.——N.W. LONDON BRANCH: Prince of Wales Hotel, Kingsbury Road, N.W.9, "Mechanical Refrigeration," W. C. Boag, 7.45 p.m.

Wed., Jan. 16th.—MANCHESTER BRANCH: Engineers' Club, Albert Square, Manchester, "Toughened Glass," Film and Lecture, R. Glover, 7.30 p.m.

Thurs., Jan. 17th.—KENT BRANCH: Royal Star Hotel, Maidstone, "Cold Cathode Lighting," G. Singleton, 8 p.m.

British Institution of Radio Engineers

Tues., Jan. 15th.—S. MIDLANDS SECTION: Public Library, Rugby, "Propagation and Reception of Television Signals," G. L. Stephens, 7.15 p.m.

Thurs., Jan. 17th.—SCOTTISH SECTION: The University, Drummond Street, Edinburgh, "Television Aerials," G. L. Stephens, 7 p.m.

Illuminating Engineering Society

Wed., Jan. 16th.—TEES-SIDE GROUP: Cleveland Scientific and Technical Institution, Corporation Road, Middlesbrough, "The Design of Lighting Fittings," S. S. Beggs, 6.30 p.m.

Thurs., Jan. 17th.—GLOUCESTER AND CHELTENHAM CENTRE: General Electric Co., Ltd., St. Aldgate Street, Gloucester, "Lighting on the 'Queen Elizabeth' and the 'Caronia,'" T. Catten, 6.15 p.m.——LEICESTER CENTRE: E. Midlands Electricity Board, Charles Street, Leicester, Film and Discussion Evening, 6.30 p.m.

Incorporated Plant Engineers

Mon., Jan. 14th.—GLASGOW BRANCH: Engineering Centre, 351, Sauchiehall Street, Glasgow, Discussion, "Can Work-Study and Incentive Bonus Schemes be Successfully Applied to Maintenance Work?" A. J. MacIntyre and J. Campbell versus James Black and H. W. Dinwoodie, 7 p.m.——DUNDEE BRANCH: Mathers Hotel, Dundee, "Heat Transfer," R. A. Brecknell, 7.30 p.m.

Thurs., Jan. 17th.—LIVERPOOL AND NORTH WALES BRANCH: Radiant House, Bold Street, Liverpool, "The Processing and Uses of Armour Plate and Toughened Glass," 7.15 p.m.

Institute of British Foundrymen

To-day, Jan. 11th.—MIDDLESBROUGH BRANCH: Head Wrightson and Co., Ltd., Teesdale Iron Works, Thornaby-on-Tees, "Process Planning in the Steel Foundry Industry," S. L. Finch, 7.30 p.m.

Sat., Jan. 12th.—LANCASHIRE BRANCH: Engineers' Club, Albert Square, Manchester, "Some Examples of Loam Moulding, Ferrous and Non-Ferrous," E. Clipson, 3 p.m.——W. RIDING OF YORKSHIRE BRANCH: Technical College, Bradford, "A System of Castings' Defects," G. W. Nicholls and D. T. Kershaw, 6.30 p.m.

Tues., Jan. 15th.—SLOUGH SECTION: High Duty Alloys, Ltd., Slough, "Modern Melting Practices," F. Evans, 7.30 p.m.

Wed., Jan. 16th.—N.E. SCOTTISH SECTION: Imperial Hotel, Keptie Street, Arbroath, "Cross Section of a Non-Ferrous Jobbing Foundry," J. Gorman, 7.30 p.m.

Institute of Fuel

Tues., Jan. 15th.—Institution of Mechanical Engineers, Storey's Gate, St. James's Park, London, S.W.1, "Llandarcy and Fuel Efficiency," R. B. Southall, 5.30 p.m.

Institute of Industrial Supervisors

Mon., Jan. 14th.—DUDLEY SECTION: Technical College, Dudley, Annual General Meeting and Industrial Film Show, 7.30 p.m.

Tues., Jan. 15th.—BIRMINGHAM SECTION: Technical School, Redditch, American Supervisory Training Films, introduced by F. Scarborough, 7.30 p.m.

Wed., Jan. 16th.—BRISTOL SECTION: Grand Hotel, Bristol, Annual General Meeting, "English Expression and Usage," W. B. Armstrong, 7.30 p.m.

Thurs., Jan. 17th.—WARRINGTON SECTION: White Hart Hotel, Warrington, Annual General Meeting and Section President's Address, 7 p.m.——NEWARK SECTION: County Technical College, Newark, Annual General Meeting and Section President's Address, 7.30 p.m.——COVENTRY SECTION: Craven Arms Hotel, High Street, Coventry, Annual General Meeting and Chairman's Address, 7.30 p.m.

Institute of Marine Engineers

Thurs., Jan. 17th.—Liverpool College of Technology, Byrom Street, Liverpool, 3, "Modern Naval Boilers," J. I. T. Green, 7 p.m.

Institute of Metals

Tues., Jan. 15th.—S. WALES LOCAL SECTION: University College, Metallurgy Department, Singleton Park, Swansea, "Metallurgy and Transport," T. Henry Turner, 6.30 p.m.

Institute of Navigation

Fri., Jan. 18th.—Royal Geographical Society, 1, Kensington Gore, London, S.W.7, "Navigational Errors," R. W. Anderson, 5 p.m.

Institute of Petroleum

Wed., Jan. 16th.—STANLOW BRANCH: Grosvenor Hotel, Chester, Annual General Meeting, 7.30 p.m.

Institute of Road Transport Engineers

Tues., Jan. 15th.—SCOTTISH CENTRE: Visit to Works of Scottish Cables, Ltd., Deanside Works, Renfrew, 7.15 p.m.——N.W. CENTRE: Victoria Hotel, Wigan, "Vacuum and Air Brakes," S. H. Edge, 7.30 p.m.——MIDLANDS CENTRE: Crown Inn, Broad Street, Birmingham, "Dieselisation," S. Johnson, 7.30 p.m.

Thurs., Jan. 17th.—N.E. CENTRE: Hotel Metropole, Leeds, "Technical Education," Clifford Chew, 7.30 p.m.——LONDON CENTRE: Royal Society of Arts, John Adam Street, London, W.C.2, "Development in Tyre Construction and the Use and Abuse of Tyres," W. R. Good, 7.30 p.m.

Institution of Chemical Engineers

Fri., Jan. 18th.—GRADUATES' AND STUDENTS' SECTION: Caxton Hall, Westminster, London, S.W.1, "Management," D. I. W. Atkinson, 6.30 p.m.

Institution of Civil Engineers

Tues., Jan. 15th.—Great George Street, Westminster, S.W.1, "Oil Loading and Cargo Handling Facilities at Mina al-Ahmadi, Persian Gulf": Part I, "Planning and Design," C. W. N. McGowan; Part II, "Construction," R. C. Harvey and J. W. Lowdon, 5.30 p.m.

Institution of Electrical Engineers

Mon., Jan. 14th.—LONDON STUDENTS' SECTION: Savoy Place, W.C.2, Film Evening, 7 p.m.

Tues., Jan. 15th.—N. MIDLAND STUDENTS' SECTION: The University, Leeds, Chairman's Address, E. C. Walton, 6.30 p.m.

Wed., Jan. 16th.—RADIO SECTION: Savoy Place, London, W.C.2, "Comparison of Ionospheric Radio Transmission Forecasts with Practical Results," A. F. Wilkins and C. M. Minnis, 5.30 p.m.

Fri., Jan. 18th.—N.E. STUDENTS' SECTION: Grey Hall, King's College, Newcastle upon Tyne, Problems Night, 6.30 p.m.

Institution of Engineering Inspection

Wed., Jan. 16th.—School of Economics, Dundee, "The Institution," H. P. Middleton, 7.30 p.m.

Institution of Locomotive Engineers

Wed., Jan. 16th.—Institution of Mechanical Engineers, Storey's Gate, St. James's Park, London, S.W.1, "New Steel Electric Railway Stock for the Indian Government Railways," S. E. Lord, H. H. C. Barton and J. F. Thring, 5.30 p.m.

Institution of Mechanical Engineers

To-day, Jan. 11th.—SCOTTISH BRANCH: North British Station Hotel, Glasgow, "Steel Castings and the Engineer," J. F. B. Jackson, 6.30 p.m.

To-day, Jan. 11th.—Storey's Gate, St. James's Park, London, S.W.1, "Rubber Technique in Engineering," John Kelly, 5.30 p.m.

Thurs., Jan. 17th.—N.W. BRANCH: Engineers' Club, Albert Square, Manchester, "Latest Developments in High-Speed Steel Tool Materials," K. J. B. Wolfe, 6.45 p.m.——SCOTTISH BRANCH, GRADUATES' SECTION: Royal Technical College, Glasgow, "Shop Testing of Marine Diesels," W. S. Harvey, 6.30 p.m.

Fri., Jan. 18th.—W. BRANCH, GRADUATES' SECTION: College of Technology, Unity Street, Bristol, "Planned Maintenance," R. K. B. Lyne, 7 p.m.——Storey's Gate, St. James's Park, London, S.W.1, Thomas Lowe Gray Lecture: "Ship Research," S. Livingston Smith, 5.30 p.m.

Institution of Mining and Metallurgy

Thurs., Jan. 17th.—Geological Society, Burlington House, London, W.1, "Mineralisation at Castle-an-Dinas Wolfram Mine, Cornwall," D. Kear, ; "The Production of Pure Cerium Metal by Electrolytic and Thermal Reduction Processes," P. M. J. Gray, 5 p.m.

Institution of Post Office Electrical Engineers

Tues., Jan. 15th.—Institution of Electrical Engineers, Savoy Place, London, W.C.2, "New Aids to the Maintenance Testing of Telephone Exchange Equipment," W. J. Marshall, 5 p.m.

Institution of Production Engineers

Mon., Jan. 14th.—YORKSHIRE SECTION: Hotel Metropole, Leeds, "Modern Development in Heat Treatment Practice," K. J. B. Wolfe, 7 p.m.——SHEFFIELD SECTION: Royal Victoria Station Hotel, Sheffield, "Hot Press Forging," H. E. Hows, 6.30 p.m.

Tues., Jan. 15th.—LONDON GRADUATE SECTION: 36, Portman Square, W.1, "Some Applications of Laminated Plastics as an Engineering Material," P. Smith; "Unusual Uses of Plastics in Engineering," G. Haim, 7.15 p.m.

Wed., Jan. 16th.—BIRMINGHAM SECTION: James Watt Memorial Institute, Great Charles Street, Birmingham, "Vitreous Enamelling," S. Hallsworth, 7 p.m.——EDINBURGH SECTION: North British Station Hotel, Edinburgh, "Human Relations in Industry," W. P. Kirkwood, 7.30 p.m.——WESTERN SECTION: Grand Hotel (Beaufort), Bristol, 1, "Productivity and the Machine Tool," N. Stubbs, 7.15 p.m.——YORKSHIRE GRADUATE SECTION: Great Northern Hotel, Wellington Street, Leeds, 1, "Position of the Metallurgist," R. Goodacre, 7 p.m.

Thurs., Jan. 17th.—COVENTRY GRADUATE SECTION: Hare and Squirrel Hotel, Cow Lane, Coventry, "Design and Application of Tungsten Carbide to Blanking and Piercing Press Tools," K. L. Pickett, 7.15 p.m.——GLASGOW SECTION: Institution of Engineers and Shipbuilders, 39, Elmbank Crescent, Glasgow, "British Watch and Clock Production," R. Lenoir, 7.30 p.m.——WOLVERHAMPTON GRADUATE SECTION: Star and Garter Hotel, Victoria Street, Wolverhampton, "Education for Industrial Management," T. U. Matthew, 7.30 p.m.

Fri., Jan. 18th.—EASTERN COUNTIES SECTION: Public Library, Northgate Street, Ipswich, "Production Engineering as a Career," T. B. Worth, 7.30 p.m.——MANCHESTER GRADUATE SECTION: Reynolds Hall, College of Technology, Manchester, 1, "The Uses of Glass in Industry," W. M. Hampton, 7.15 p.m.——N.E. GRADUATE SECTION: Neville Hall Mining Institution, Newcastle upon Tyne, "The Organisation of Production and Planning," B. E. Stokes, 7 p.m.——W. WALES SECTION: Central Library, Alexandra Road, Swansea, "Industrial Maintenance of Machines," R. M. Buckle, 7.30 p.m.

Institution of Structural Engineers

Wed., Jan. 16th.—NORTHERN COUNTIES BRANCH: Neville Hall, Newcastle, "Reconstruction of the Houdon-on-Tyne Gas Works," W. R. Garrett, 6.30 p.m.——YORKSHIRE BRANCH: Great Northern Hotel, Leeds, "Structural Engineering at Abbey Works," A. V. Hooker, 6.30 p.m.

Junior Institution of Engineers

To-day, Jan. 11th.—39, Victoria Street, London, S.W.1, "Aircraft Hydraulics," E. H. Bowers, 6.30 p.m.

Mon., Jan. 14th.—N.W. SECTION: Manchester Geographical Society, 16, St. Mary's Parsonage, Manchester, "Enterprise in Engineering," F. R. Banks, 7.30 p.m.

Fri., Jan. 18th.—39, Victoria Street, London, S.W.1, "Concrete Quality Control," S. J. Crispin, 6.30 p.m.

Liverpool Engineering Society

Wed., Jan. 16th.—24, Dale Street, Liverpool, "The Bouellat Radiant Water Tube Boiler," F. W. Bauer, 6 p.m.

Liverpool Metallurgical Society

To-day, Jan. 11th.—Electricity Service Centre, Whitechapel, Liverpool, "The Use of Radioactive Tracers in Metallurgical Research," H. M. Finniston, 7 p.m.

Manchester Association of Engineers

To-day, Jan. 11th.—Engineers' Club, Albert Square, Manchester, "Modern Engineering Aspects of Water Supply," R. W. Clarke, 6.45 p.m.

North-East Coast Institution of Engineers and Shipbuilders

To-day, Jan. 11th.—Mining Institute, Newcastle upon Tyne, "Fuelling at Sea," I. McD. Black, 6.15 p.m.

Old Centralians

Mon., Jan. 14th.—Chez Auguste Restaurant, 47, Frith Street, London, W.1, "Petroleum Developments in Desert Areas," C. A. P. Southwell, 12.55 p.m.

Society of Chemical Industry

Thurs., Jan. 17th.—ROAD AND BUILDING MATERIALS GROUP: Institution of Structural Engineers, 11, Upper Belgrave Street, London, S.W.1, "Modern Quarrying Practice and Some Problems Connected with Crushing, Cutting and Polishing Granite," G. H. Hodgson, 6 p.m.

Calendars and Diaries

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